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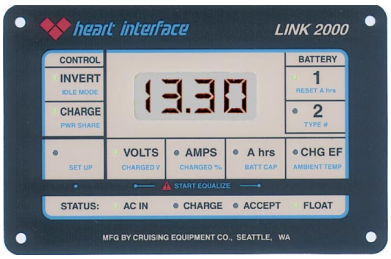

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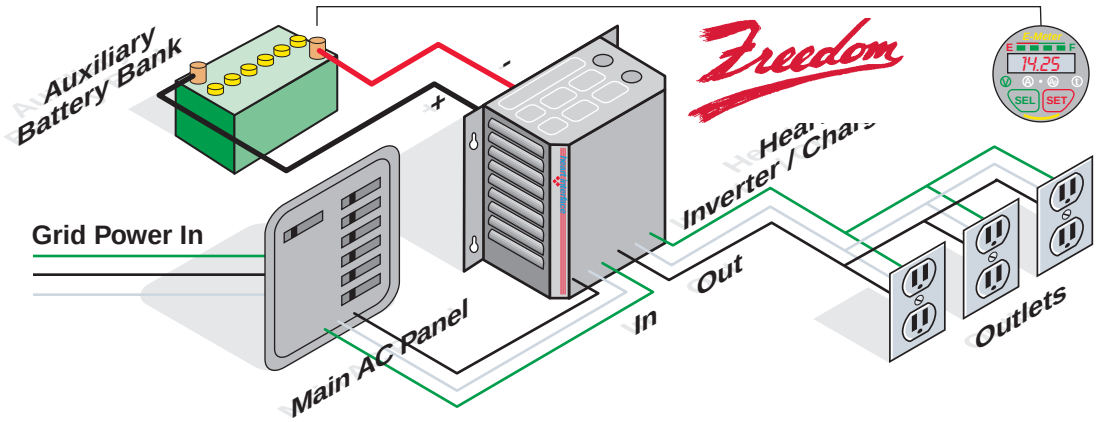
Typical Back Up Power System



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HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #57 February / March 1997

Features

GoPower

Fundamentals

Features

Things that Work!

Cover: Sunset atop Dan Whitehead's tower with insets of solar food drying, a PV system, and an electric race car.

Homebrew

Columns

Regulars

Access and Info

Access Data

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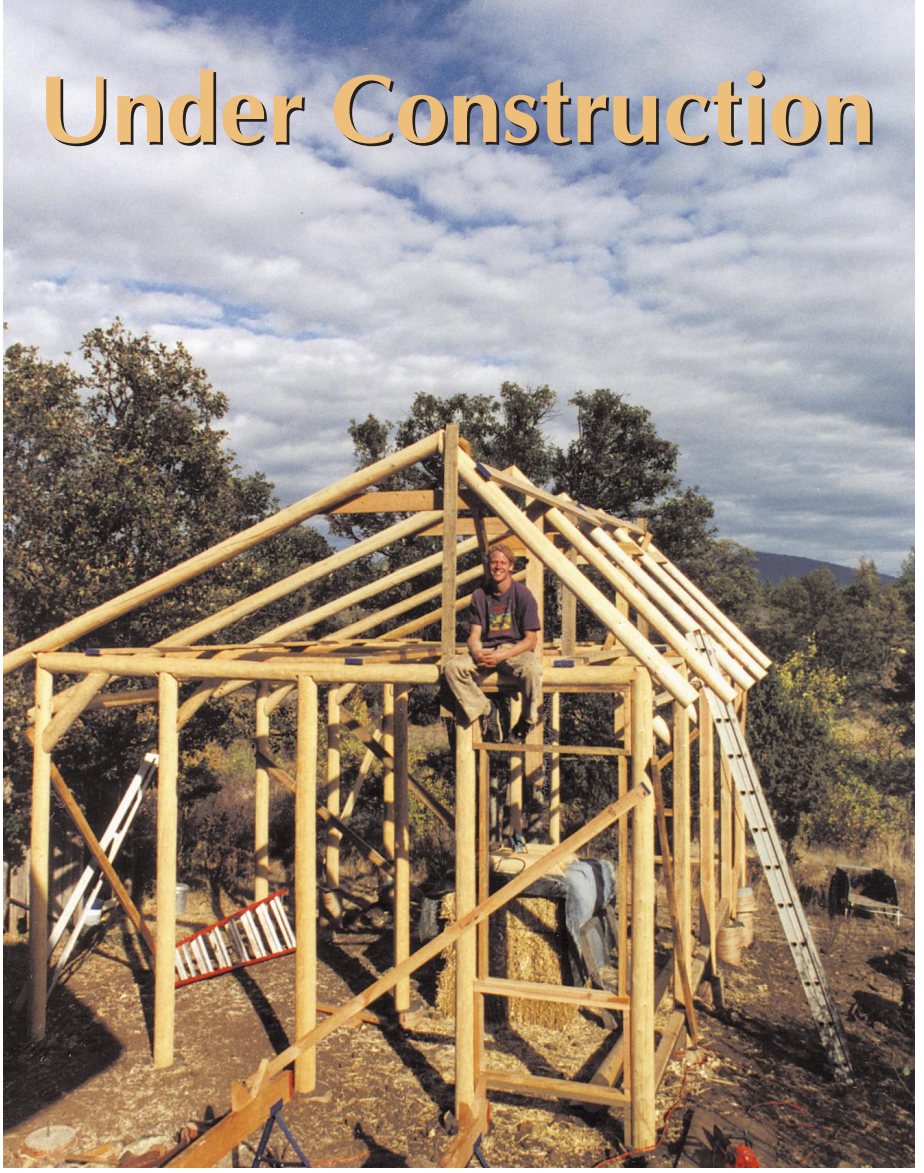
Under Construction



By now our friends in the industry and most of our readers know that *Home Power* central, here at Agate Flat, is less than extravagant, it might even be considered rustic. But homesteading is a never ending process and, alas, it is time once again to make moves towards the plush decadence of the nineteenth century.

So begins a project to provide us, the occupants of the plywood palace, with the luxuries of an indoor toilet, indoor shower with genuine hot water, and a critter proof garden bed. Joe Schwartz (pictured above) is the construction guru in charge of this 16' by 24' bath house / green house. The goal is to integrate local, renewable, low embodied energy building materials to create a space that is energy efficient, practical, and pleasant to inhabit. Straw bale north walls will be stuccoed with the local mud (sticky stuff). South windows are salvaged double pane, low-e, argon filled. It's nifty how the most ecologically sensible solutions are often the least expensive labor intensive construction techniques also save money, cuz we're doing it ourselves.

Once completed, the building will house a composting toilet system, sink, shower and tub, clothes washer, solar hot water system with propane back-up, wood stove back-up for the passive solar heat, and a large indoor garden bed. Of course, being that we are solar nerds, we will have to equip the building with a renewable energy system. Yeah, PV and maybe even wind.

Look for future articles on construction techniques, and the hot water, power, composting toilet, and grey water systems. –Ben

People

William von Brethorst
Mike Brown
Phil Brown
Sam Coleman
Steve Cooper
John Drake
Rich Hunter
Kathleen Jarschke-Schultze
Stan Krute
Don Loweburg
Harry Martin
Tara Miller
Karen Perez
Richard Perez
Shari Prange
Benjamin Root
Dennis Scanlin
John Schaefer
Bob-O Schultze
Michael Welch
Leigh & Pat Westwell
Dan Whitehead
John Wiles
Myna Wilson

" Think about it…"

"Water, water everywhere and not a drop to drink"

Ashland Oregon
New Year's Day 1997

SOLAR DEPOT

four color on film

full page, bled

this is page 5

A Low Budget Cabin System

William von Brethorst

Above: The Zars Homestead with its new PV and wind power system.

About 10 miles north of Hayden, Colorado is the Zars Homestead which has been in existence for over 100 years. It has been without electricity or services from the beginning. The present owner, Reed Zars of Laramie, has been slowly re-building the main cabin after a fire caused by lightning destroyed the original structure. He had a limited budget and wanted systems and designs which could be upgraded as building use increased or as new services and amenities were added. For now, the cabin is used only on weekends and occasionally for three or fours days at a time during holidays.

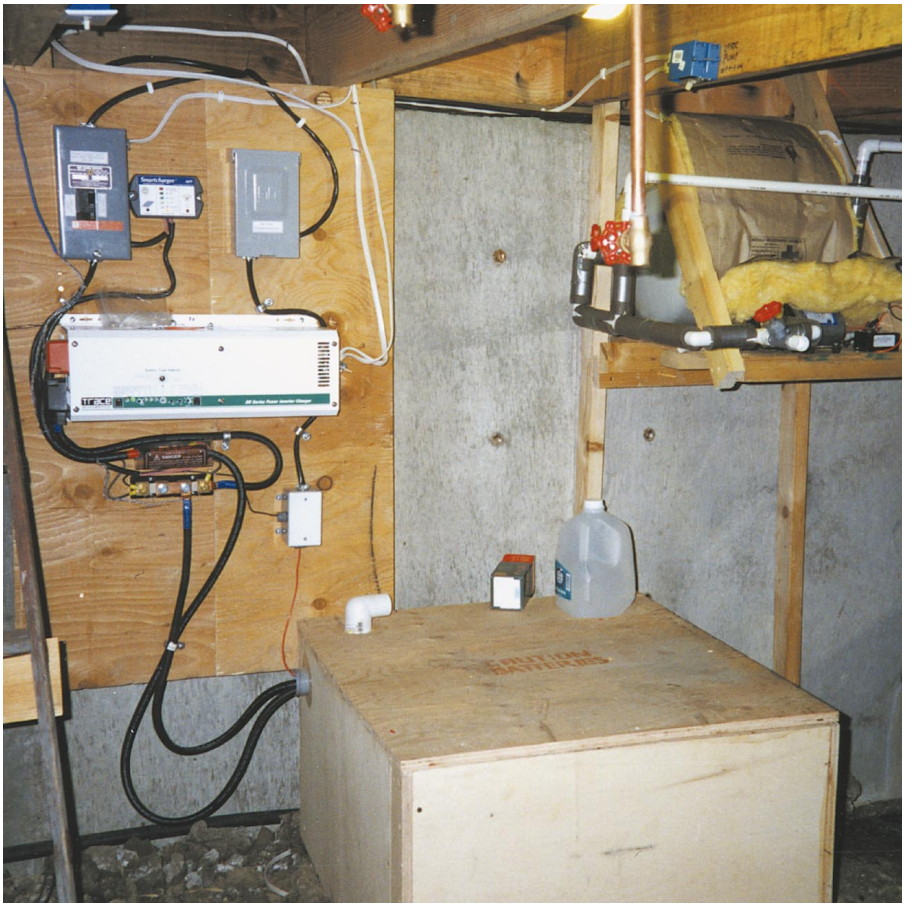
The property has the distinct advantage of a year-round spring piped into the cabin crawl space (a delight, in that the crawl space was almost 6 feet high and the full length of the cabin). The spring was generally available even in the depths of winter, though sometimes the transfer pipe froze up. The spring provides about 10 gpm but only about 5 to 10 psi in pressure. This could not properly supply the toilet and sinks, nor safely supply the propane water heater.

The Plan

After the usual preliminary "what-if?" scenarios, a plan was decided on to install the main components of a system for water, heat, and electricity that would allow future re-work as cabin usage changes. Because the cabin is usually not heated unless occupied, all major electrical equipment was located in the crawl space. Its depth, size, and location would assure a year-round temperature difference of only 30˚ to 40˚. In the summer the space would be cool (45˚F) and in the winter, the radiated ground heat would keep the space around 30˚F.

When the cabin was not in use, the inverter would be off, but the array controller would still be active to keep the batteries charged. After much consideration, the

components chosen were a Trace DR-1524 inverter, an APT "Smart-Charger" controller, an Air-303 wind generator, two Solavolt 85 Watt modules and four Photocomm 225 Amp-hour "golf cart", wet-cell, lead acid batteries. The system voltage chosen was 24 VDC, mainly for lower line loss but also because the DC devices were 24 VDC. The batteries were mounted in an insulated box with room for four additional cells. The battery box was constructed from 3/4 inch plywood with R-11 fiberglass insulation inside and poly-cell matting over the box floor to prevent cold-sinking.



Above: The Zars Homestead's power wall with Trace 1524 inverter, insulated battery box, and pressure tank system.

Water Delivery

The water pressure problem was solved by adding a small 24 VDC booster pump with a pre-charged pressure tank to prevent constant cycling of the pump. The Shur-Flo 3.1 gpm pump was installed and plumbed so it could be bypassed in case of failure (as diaphragm pumps wear out faster than centrifugal pumps). A valve system allows the spring to feed the house directly, if required. A BZ products low-voltage disconnect was added so that in the event of a leak, the pump would not run continuously and completely discharge the batteries. A manual on-off switch was also installed.

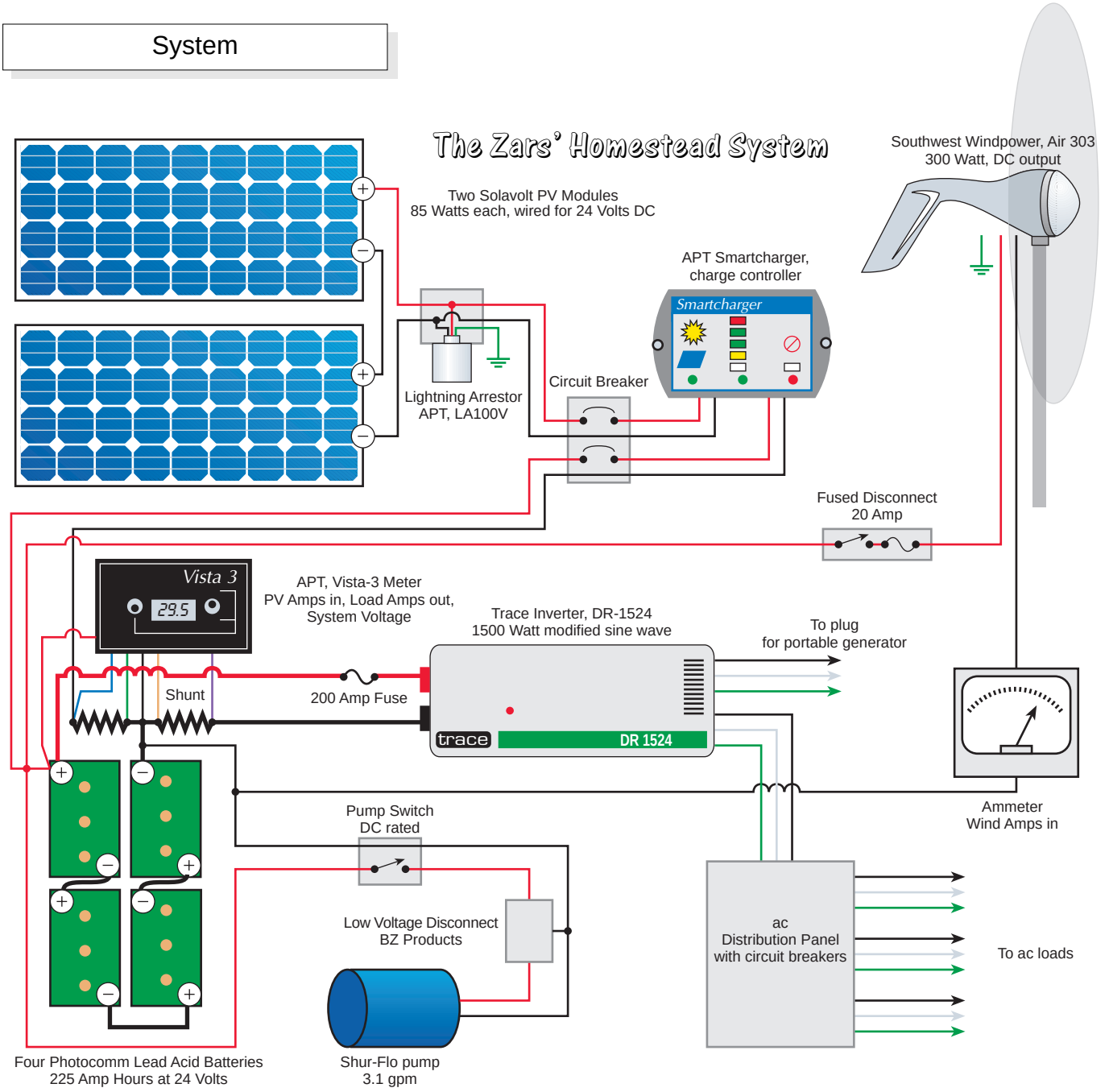
Electrical

The system inverter and controls were pre-fabricated on a plywood board and wired and tested in the Planetary Systems shop in Jackson. We did this

Below: Electrician Skip Chisolm installs the 120 vac service panel.

System Component Costs

#	*Component*	*Cost*	*%*
1	House Wiring & Installation	$1,135	21%
2	Solavolt 85W PV modules	$870	16%
1	Vestfrost Fridge	$800	15%
1	Trace Inverter	$795	15%
1	PV/Wind Installation	$500	9%
1	Air-303 Wind Generator	$495	9%
4	Lead-acid Batteries	$312	6%
1	Controls/Disconnects/Wire	$288	5%
1	Mounting	$100	2%
	Total System Cost	$5,295	



because the site was really remote. A failure on-site could have been costly to the homeowner (and installer). This also saved time and cost for the homeowner. The entire system was installed and up-and-running in 22 hours, including ac wiring of the house lights, switches, and outlets. The loads for this system were very light, but the ability to expand the system for heavier use was built in. Lighting was ac compact fluorescent and the fridge was ac. The cabin included some propane lamps for use when power was low, and the main heat source was a wood stove.

Wind Genny

The Air-303 wind generator was mounted at the ridge of the building about 6 feet above the roof for a very good reason. The winds at the site range from 16 to 35 miles per hour average. A taller tower would have necessitated a much sturdier mount, thus more cost. With the famous (infamous) Wyoming winds, this site can have very heavy gusts. The tower height also kept the wire run short for less voltage loss. The average output from this unit has ranged from 50 to 185 Watts, easily enough to operate the fridge without any solar input.

This expandable system's battery box is designed accommodate up to eight golf cart type batteries at about 450 Amp hours of storage. With the addition of another Trace model 1524 inverter, the owner can increase his ac output capacity to 3000 watts continuous.

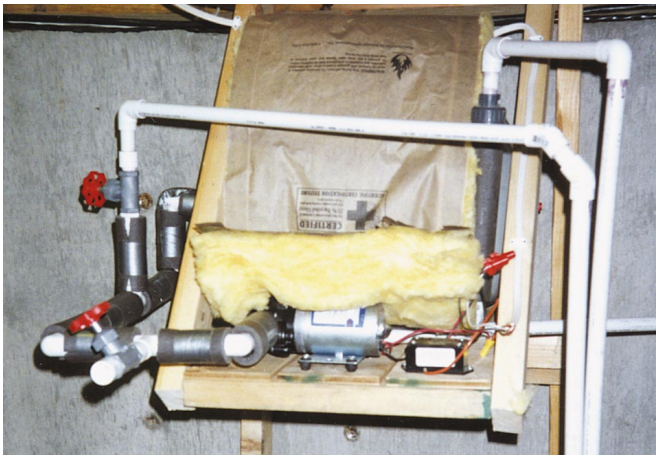
The final touch was adding an outside weatherproof box with a plug to connect a generator for backup

System Load Table

#	Appliance	Run Watts	Hours /Day	Days /Week	W-hrs /Day
1	Fridge (Vestfrost)	120	6	2	206
1	Pump 24 VDC	86	1	2	25
2	Liv. Rm. Lights	16	2	2	18
2	Kitchen Lights	16	2	2	18
1	Bath Light	16	3	2	14
3	Upstairs Lights	16	1	2	14
1	TV	40	1	2	11
2	Outside Lights	16	1	2	9
1	Stereo	20	1	2	6
	Energy Consumed Daily in Watt-hours				321

power or additional charging when required. The Trace's charger input settings can be adjusted to match the output of even the smallest portable generator, allowing complete flexibility. Following the installation of the drywall and plumbing, the place was operational, cozy, and warm.

This installation is an example of what can be accomplished with even a limited budget and some extensive pre-planning by an experienced PV designer/installer who can also be on-site to see that things are done properly.



Above: Detail of the pressure tank (wrapped in insulation), 24 Volt Shur-Flo Pump, and BZ Products low voltage Disconnect.

Access:

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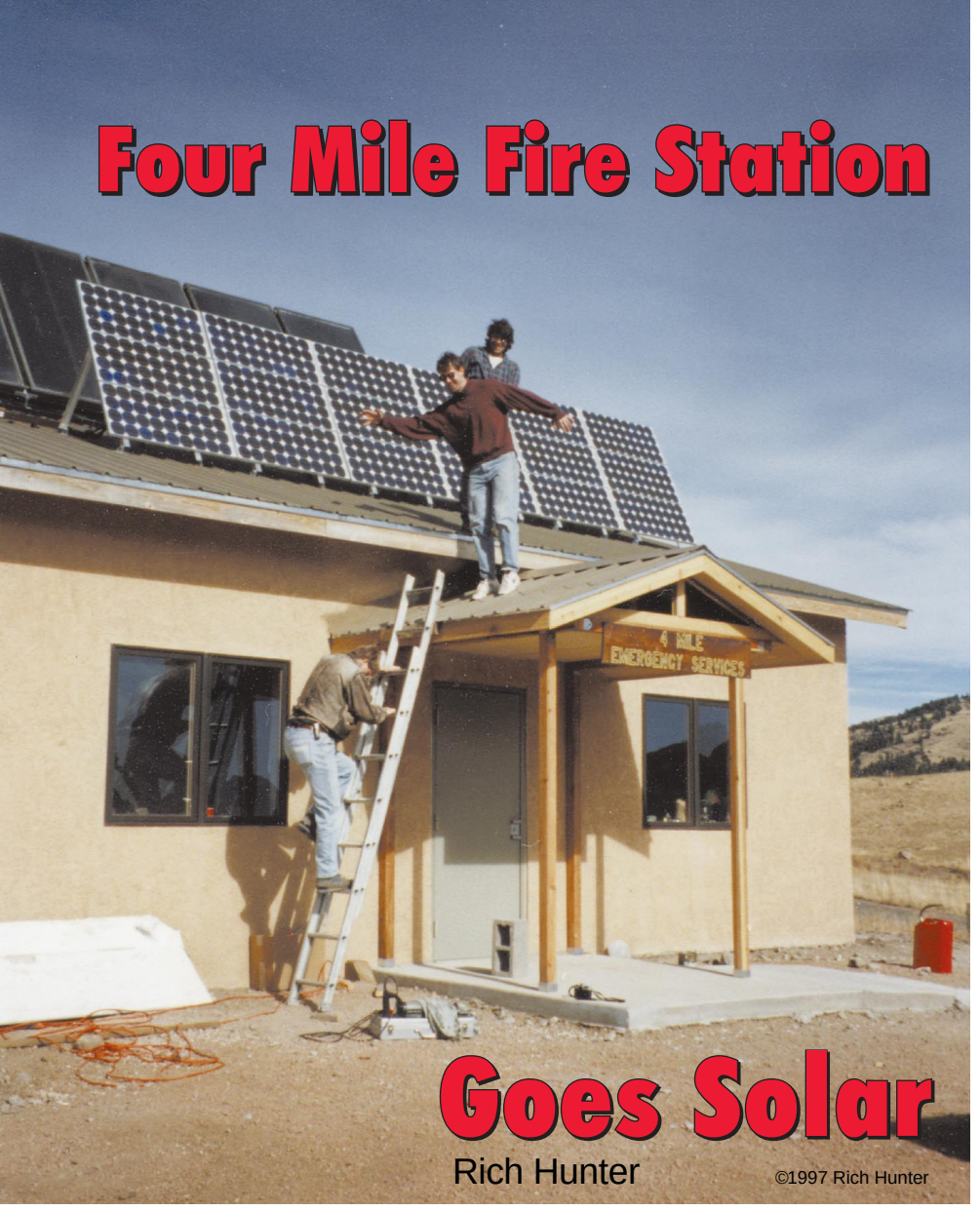
Four Mile Fire Station Goes Solar



Rich Hunter

Four Mile Fire Station, a volunteer organization started in 1984 to provide fire and ambulance services for 69 square miles of Teller County and ambulance service for 235 square miles of Park County in central Colorado, has recently completed construction of their new building. Located over a mile from the nearest utility lines, the volunteers decided on solar to provide their electric power. The site houses emergency equipment and is used for meetings and training as well as serving as the command center when the volunteers are called to duty.

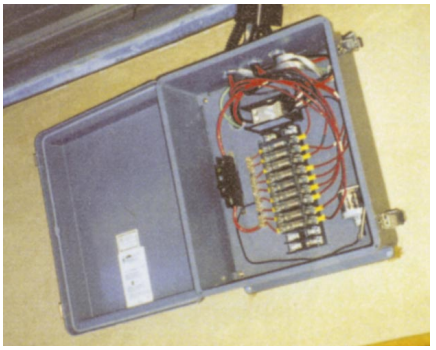
Tackling the Bureaucracy

With a clear picture of what was needed and almost limitless energy, Andy McKee, Four Mile Area Fire Chief and project engineer for the construction project, set about defining and financing the photovoltaic portion of the construction effort in early 1995. Helped by Marc Roper of the Colorado Office of Energy Conservation, Hal Post of Sandia National Laboratories and others, he developed a comprehensive design specification with clearly identified objectives for performance. Armed with this tool, Andy went the rounds of financial institutions and funding sources for several months, finally securing financing assistance from Sandia, Public Service of Colorado and local volunteers.

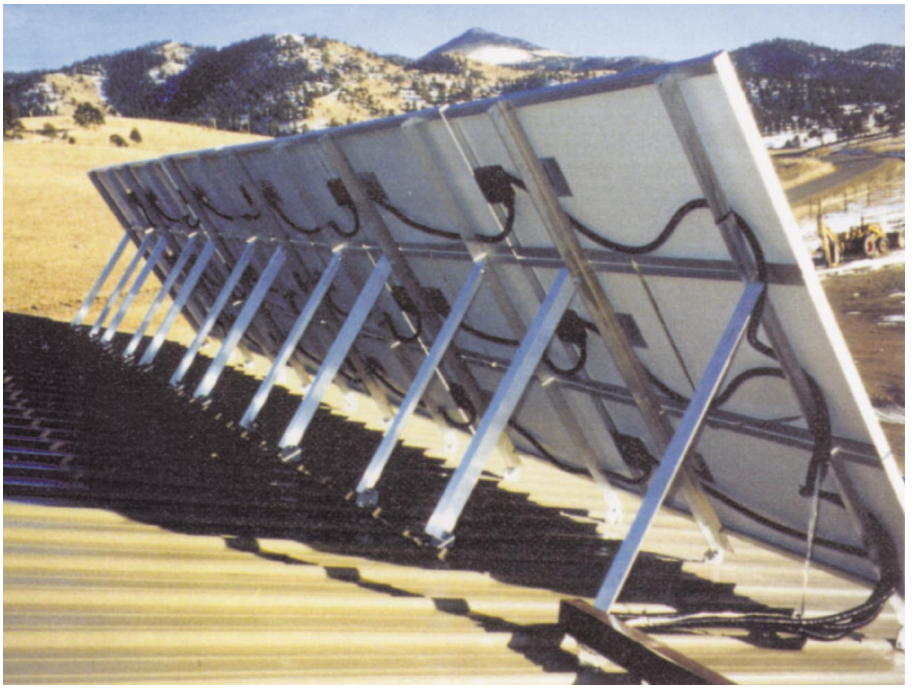
Contract Awarded to Local Firm

Discover Solar Engineering, located in Divide, Colorado was one of several firms selected to receive a request for quotation for the photovoltaic system installation. Andy and his team reviewed the bids and awarded the contract to Discover Solar Engineering in September 1995. Very competitive pricing and near-by location were keys to the selection. The system design phase was greatly simplified due to the completeness of the specifications. With computer design assistance from Solar Electric Specialties of Santa Barbara, CA, Discover Solar was able to precisely calculate the best fit of panels, inverter and batteries to match the needs for the fire services' building. During evaluation of bids, it was decided to go with Pacific Chloride 2 volt deep cycle batteries for extended life. These batteries, along with the other major components, Siemens PC-4JF 75 watt panels, Trace 4024 4000 watt true sine wave inverter and the Ananda APT power center, were all selected with the intent of providing a highly reliable, long lasting system, designed for years of trouble free operation.

A complete written contract was prepared and agreed upon before beginning work. Materials, expected performance, system design, labor provided, and warranties, were spelled out in advance. Knowing who is going to do what and what the finished system will deliver before you start is the best way to assure satisfaction.



Above: The PV combiner box contains fuses for each 24 Volt pair, a circuit breaker, and an APT lightning arrestor.



Right: The eighteen Siemens modules were racked and bolted directly to the station's metal roof.

As part of the contract, agreement was made to cooperate on the installation labor. Volunteers helped on a variety of tasks such as mounting the arrays on the roof, building a battery enclosure, assisting in pulling cable and many other tasks. The installation cost was kept to a minimum by the outstanding effort of several volunteers.

Working with a crew of dedicated assistants, installation was started in October before the really cold weather and snows arrived. We met on a weekday morning and determined how we would proceed with the help and scheduling availability of the volunteers. First, Andy and his team built the battery enclosure and installed the wall support for the inverter and APT Power Center. Then, we all worked together for several days securing the roof mounts to the metal-roofed building. Since we were going to install solar heat collectors to aid in heating the building, in addition to the photovoltaic panels, space on the south facing roof was at a premium. The PV panels were firmly secured on the lower portion of the roof with Andy crawling under the rafters and atop the previously installed sprayed insulation inside the building while Sandy Knox, another dedicated volunteer, and I drilled holes and fed the mounting screws down to him from the outside. In all, the volunteers contributed about 140 hours of effort. The installation was completed by the first week in November.

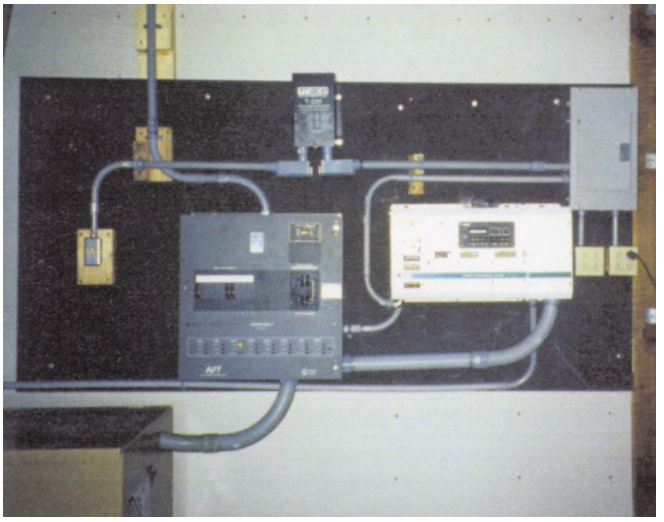
PV System Components

The system was designed to be completely automatic and provide sufficient electric power to meet the expected part-time operation needs of the volunteer organization.

18 Siemens PC-4JF 75 watt panels were mounted, 3 panels per mount, on the south facing roof above the office area. These panels operate especially well in cold weather and typically output the rated 4.4 amps per module in a full sun condition. The current output is the key determinant in evaluating actual output power. The nine pairs of panels deliver a total of over 40 amps on clear sunny days. At 25 volts nominal, and an average 6 hour sun day, this results in 6000 watts hours of energy stored each day. This is considerably less than the 75 watts of rated power per panel times 6 hours per day, but is well above the amount needed to meet the system requirements.

Two panels were wired in series to create 24 volt sets. Pairs of 12 gauge wires from each set were individually run from the panels to an array combiner box located on the western wall of the equipment bay building. The array combiner consists of individual fuses for each panel pair, a main 60 amp DC rated circuit breaker, a negative lead bus bar and a lightning arrestor all mounted in a weatherproof plastic enclosure. The wire size was determined by calculating the acceptable 2% maximum loss allowable over the total distance from the farthest panel pair to the array combiner assembly.

The power was fed from the panels to a 60 amp charge controller installed in the APT control center which was located in the first bay of the equipment area. 6 gauge THHN wire was used for this run. The size again being determined by calculating for a maximum of 2% loss



Above: The power wall with Ananda Power Center, Trace 4 Kilowatt inverter, and step up transformer.

from the array combiner to the control panel. By paying careful attention to wire sizing and minimizing lengths of cable runs, we managed to conform to all building codes and keep system wiring losses to well under 5% for the total system.

The batteries, 12 Pacific Chloride 2 volt deep cycle batteries with a combined storage capacity of 1270 AH, were considerably more expensive than some other commonly used residential batteries (e.g. the L-16 6 volt 350 AH units), but should provide a much longer life time. They are very heavy, each cell of the 85CB-25 weighs about 150 LB, but the more lead, the more power and the longer the battery life.

The DC power was converted to 120 volt ac through a Trace 4024 true sine wave inverter. Requirements for the emergency services operation includes using a small computer for record keeping and battery charging to charge their portable phones. It was felt that the sine wave inverter would best handle these types of loads. In addition, it is planned to use this inverter to control a standby propane fired generator for additional power generation in the near future. This sine wave inverter is rapidly becoming a standard for residential PV systems. It offers plenty of power for most applications, and the programming features, internal metering and high charging capability are all features valuable to the user.

An APT control center houses safety fuses, charge controller, and system metering. A 60 amp charge controller was selected to allow room for expansion should more panels be added in the future. The charge controller circuitry has a normal setting for regular operation and an equalize setting to allow "over-charging" of the batteries from the PV panels on a periodic basis. The APT metering consists of a "smart light" meter to allow casual monitoring of battery condition and a Vista-3 digital read-out meter. By selecting the proper function, the Vista-3 displays battery voltage, input current and output "load" current.

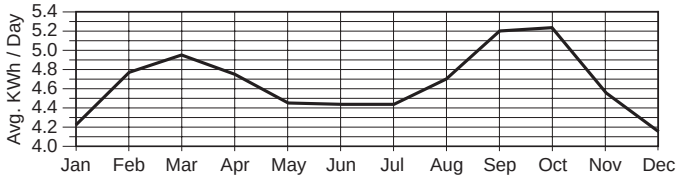
A Trace T-220 transformer completes the system. This unit "steps-up" the 120vac from the sine wave inverter to 240 vac for running large loads.

System Size Calculations

The average estimated daily energy requirement for the building is 3.7kw and the peak power is 4.8kw. With rigid load management, the maximum load will stay below 4kw. Worst month output from the panels was calculated to be 4.2kw per day in January based on the siting and the geographical location.

The PV panel output was calculated using insolation data for Eagle Colorado, a latitude of 39.65 degrees north, a longitude of 106.92 degrees west, and a tilt angle of 65 degrees. Average output per month is shown below.

Average KilloWatt Hours Per Day from a 1350 Watt PV Array



System Costs

The system was awarded to Discover Solar Engineering as a result of a competitive bid, with price being a key element in the selection process. As such, Discover Solar and its supplier, Solar Electric Specialties, pushed the limit to offer the lowest possible price. A lot of labor was "volunteered" by Discover Solar and a lot more labor was "volunteered" by members of the Emergency Services team. Total out of pocket cost to the Emergency Services Organization was $18,920.

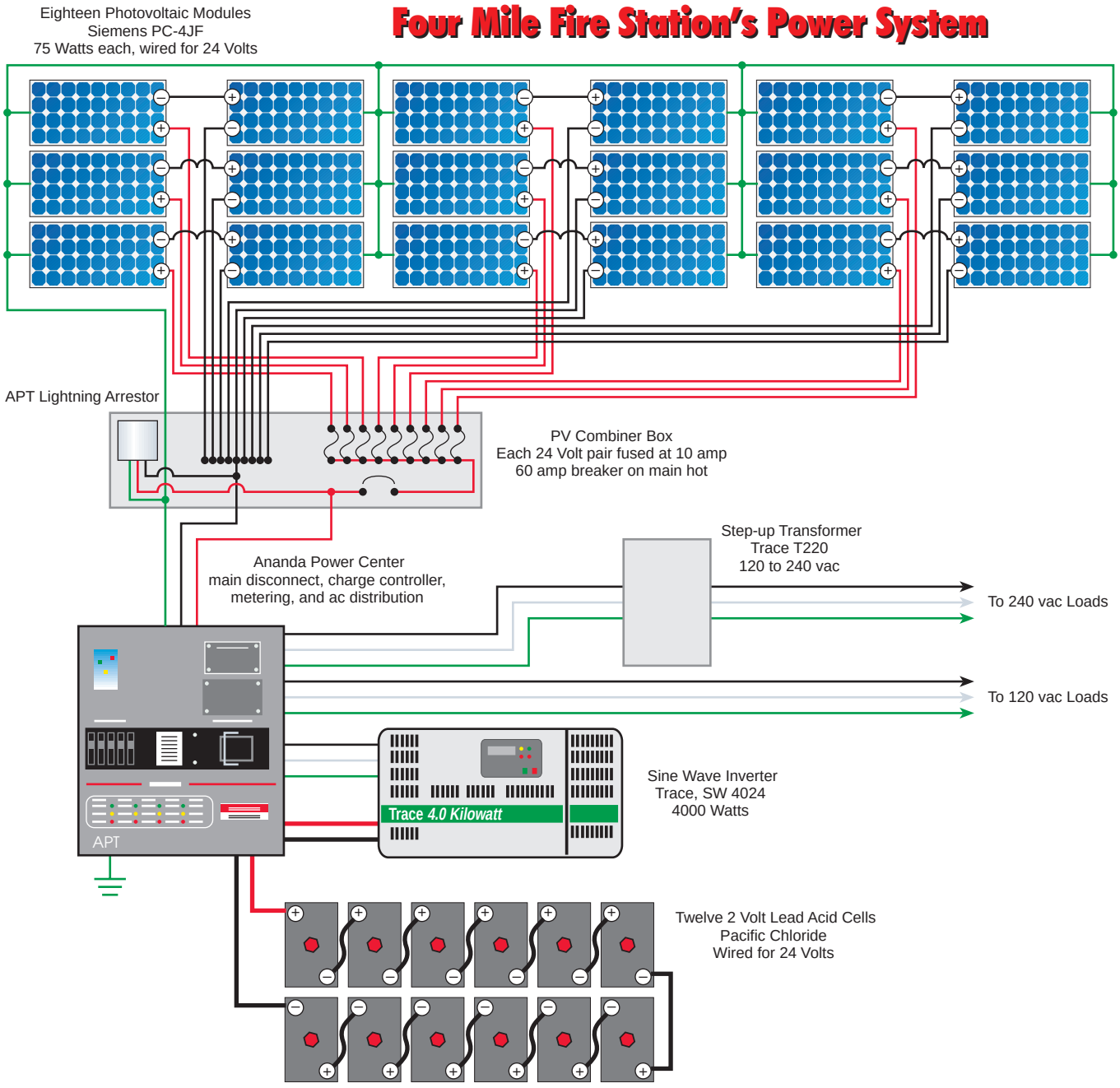
Building Codes

No job is complete until it has been inspected. In Teller County, our county electrical Inspector travels to each and every installation, no matter how small or remote

System Component Cost

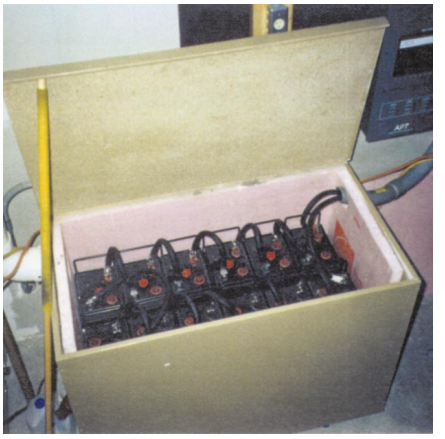
Component	*Cost*	*%*
PV Panels, Supports, Combiner	$7,930	42%
Inverter and Controls	$4,360	23%
Batteries	$3,930	21%
Labor	$2,000	11%
Installation material, wire, conduit	$700	4%
Total Cost	$18,920	

Four Mile Fire Station's Power System



the site. The emergency services building is considered a commercial building and had to meet the requirements for commercial construction in addition to conforming to all applicable residential dwelling codes.

In addition to the county electrical inspection, Andy invited representatives from the Colorado Office of Energy Conservation and Sandia Labs to attend a formal acceptance test and walk through. Mark Roper, of the COEC and Jack Cannon from Sandia came up to Florissant on a clear sunny day in November to participate. We did a lot of things the typical homeowner might not think to do, but probably should consider



Right: An insulated battery box hold the twelve Pacific Chloride 2 Volt cells, 1270 amp-hours at 24 Volt

Above: solar water panels provide about fifty percent of the space heating through hydronic sub-floor loops.

when reviewing his or her new installation. Checking panel output, switch operation, ground currents, AC performance, frequency and amplitude, to name a few. Our system passed all the tests with flying colors.

Training: The Final Step

with the system installed and up and running, schematics and technical manuals prepared, the final step was to make sure the end users knew how to operate and maintain the system. The Four Mile installation is a little unusual in that any one of several volunteers might need to know how to operate and maintain the system. We decided on a formal presentation to provide instructions to this potentially large group.

Fortunately, Jack Cannon from Sandia was able to stay on for the training class. While it is a little intimidating to try to teach PV to a class with an expert like Jack in the audience, his participation opened the doors for a variety of in-depth questions and led to a lively and informative session. While not walking away as experts in PV the four mile volunteers did get a good introduction to the subject and lots of practical advice on what to expect from their system and how to best maintain it.

Solar Heating

A separate project for the emergency services building was the installation of a solar/propane heating system to provide heat to the building during the cold winter months. A total run of three miles of tubing was laid into the 50' by 60' equipment bay when the cement floor was poured. The slab is 6 inches thick concrete, with insulation material between the concrete and the ground. In this closed loop system, a mixture of propylene/glycol and water is heated by the sun by five 4 by 8 foot solar panels mounted on the roof, fed through a boiler/mixer system and distributed to the multiple zones throughout the equipment bays. A propane fired Agua Star instantaneous hot water heater supplements the solar for heating during extra cold periods. SunFire, of Boulder Colorado, a company specializing in radiant heating systems and solar services, provided the system design, panels, heating controls, propane heater, materials and installation. Emergency services personnel waded through the setting cement to lay the tubing. The solar heating panels were purchased used to keep the system cost low. Total solar heating system cost, exclusive of the heater tubes was about $10,000. The solar portion of the system was designed to provide about 50% of the annual heating requirements for the equipment bay and the office area. It was determined that maintaining an ambient air temperature above 50 degrees F in the equipment bay would be adequate. Plans are presently underway to add a sixth panel in a month or so to provide additional heating for the office area and to further reduce dependency on the propane fired make-up boiler, but overall, the heating from the sun has been sufficient to handle most of the heating needs in the equipment bays.

Conclusion

The Four Mile Emergency Service Building's PV system has been up and running for ten months now. It has survived winds in excess of 100 mph and periods of extreme cold weather. The output has been equal to or better than expected and, (knock on wood), there have been no equipment malfunctions. A standby propane generator will be installed later this year to provide additional power to run such loads as a portable welder and other heavy duty power tools. By being practical, analyzing their needs and installing the right equipment for the job, the Four Mile Emergency Service volunteers have a fully functional off-grid power system they can be proud of.

Access

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ANANDA POWER TECHNOLOGIES

full page, bled
four color on film

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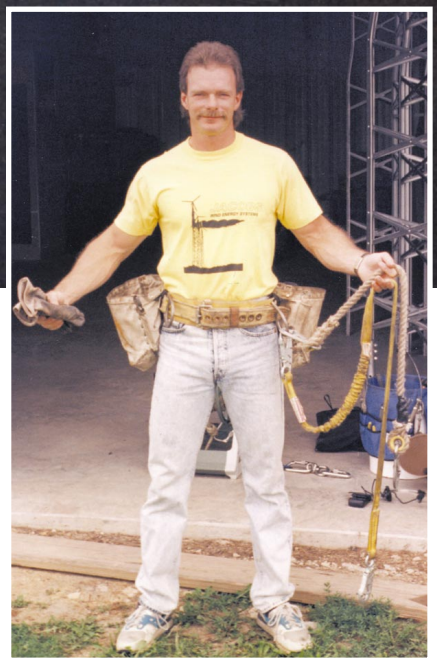
LIVING WITH A WIND MACHINE

Dan Whitehead

I once heard Michael Hackleman say that if you own a wind generator your life is an adventure. Sometimes that is an understatement.



Left: Dan with appropriate tower climbing gear: Safety belt with two lanyards,tool pouches, and work gloves.

I have lived with wind machines since 1984 and I do not regret one minute of it. I now have three machines running and am in the process of installing a fourth on our property. My wife says that four is enough. I personally do not agree since we all know that you can never have too much power. Sometimes it is an adventure and other times it is pure joy. If you sit back and do nothing, soon the wind machine will become a costly monument in your yard that will bring you nothing but grief.

Do It Yourself

If at all possible, you need to perform your own maintenance on your wind machine. This way you will learn all about your particular wind system and you will become much in "tune" with your machine. For instance, if your machine starts to make an unfamiliar sound you will immediately recognize it and possibly avoid a major problem before it happens.

If you cannot climb, help out the person you contract to do the work. Another ground crew person is always welcome during the job. This way you can stay in touch with the machine and keep an eye on the work that is being done. Use binoculars to watch the service work being performed. This way you can be assured that the work is being done to your satisfaction.

Proper Tools a Must

First and most important is to get a good safety belt. Do not ever climb the tower without it. Inspect and test the safety belt before you go up. Once you are up at the top, tie yourself off with the lanyard. You now can lean back and have the use of both hands to work. If you still have some fear of letting go with both hands, try using two lanyards. You do not really need two, but your mind will be more at ease knowing there is a backup if one breaks. This should make it much easier to let go with both hands and be at ease to work without the fear of falling off.

Next you will need some rope, about 2 1/2 times the height of your tower. Spend some money and get good quality rope. I use rock climbing rope. You can get this from any army surplus store. You will need a good quality pulley to attach up top. Leather gloves for you and the ground crew are a must. The first time you try hoisting tools up or down without gloves will show you why you need them. The rope will burn you in a hurry.

Below: The right tools (including voice activated two-way radios) can make all the difference.

Above: It's a long way up...and a long way down; work safely!

Use a 5 gallon bucket and one of those Bucket Boss tool organizers. The Bucket Boss fits into the bucket and holds all types of tools neatly. Get an assortment of wrenches, sockets, screwdrivers, pliers, and anything else that you need for your particular machine. Use another 5 gallon bucket for hoisting parts, oil, grease, etc., up and down the tower.

One thing that I have found to be quite handy is a set of two-way radios for communicating with your ground crew. It is often difficult to communicate with people on the ground from 100 feet up in the air. I use a voice-activated headset for hands-free operation. Just talk and it works. It makes the job much easier.You can get these radios from any electronics catalog or Radio Shack. My radios are Maxon brand and they came from the Damark catalog.

Time for the Climb

After the equipment has all been laid out and the ground crew briefed about the job, it is time for the climb. The words here are slow and easy. There is no need to race to the top. Also, this is not the time to sight

Left: Look Ma...Lanyards provide a hands free yet safe way to work on your tower and bird.

see—keep your mind focused on the climb. There will be plenty of time to take in the view once you are tied off at the top. If an accident is going to happen, this is the most likely time. The climb up and down is when you are most at risk so be extra careful and keep your mind on what you are doing.

Things to Check

I like to take a check list with me so I do not miss anything. First, take a general look at everything. Look for anything unusual like bolts loose or missing. Check all moving parts making sure they move freely and look for signs of wear.

Next, start your scheduled maintenance. Grease bearings, change oil, etc. As you perform these tasks pay close attention to every detail. Check every single bolt up there making sure they are tight. This is very important. Use Loctite or self-locking nuts on everything.

Next give the rotor a detailed inspection. Check each blade from top to bottom for nicks, cracks, and excess dirt and bugs. A heavily soiled rotor can lose up to 15% efficiency. It is difficult to do, but washing the blades can really help your yearly production. Grab the blade and rock it in and out from the tower checking for worn bearings in the generator or gearbox. There should be little or no noticeable play in the bearings.

Check the wiring for loose connections, but make sure the power is off first. When you think you are done, take a break and enjoy the view for a few minutes. Go back one last time and check everything again to make sure that you did not miss anything the first time through.

When everything looks good, send the tools back down and prepare to come down. This is the time to check all the tower bolts. Descend one section at a time and carefully inspect the tower for loose bolts, cracked or broken bracing, etc. If you find a problem, tie off first then work on the problem. Do not try to tighten bolts and hang on to the tower at the same time. Once you are on the ground, check any wiring connections at the tower base and back in the house at the control center.

Things to Keep It Running

Listen to the machine every day. Get used to the way it sounds in all types of wind conditions. This way if it makes a new sound you will immediately be aware of it and be able to spot small problems before they become big expensive ones. A lot of times a new noise is

Below: check the system top to bottom, including the wiring and connections from genny to house.

something that is working loose up there. If caught right away, you can quickly repair the problem and in 30 minutes be running again. But if you let that bolt fall out, you could have a catastrophic failure that might set you back thousands of dollars.

Storm Coming?

Lightning is a wind generator's biggest enemy. I advise my customers to watch the weather and shut down the machine during a thunderstorm. This means locking the brake and disconnecting the inverter from the grid. Most of the time lightning-induced power surges come back from the utility side and cause havoc with the electronics in our systems. Once in a while a tower will get hit or a nearby strike can induce a surge into the generator. This can destroy the inverter or the generator. The little bit of electricity that you will make during a thunderstorm is not worth the risk that you take. Also, the winds in a thunderstorm are violent and usually well above the maximum running speed of any machine. This puts extra stress on your machine and tower. A major rebuild can set you back thousands of dollars. It is just not worth the risk. There are plenty of windy days without the storms.

Tower work does not have to be intimidating. Have an experienced tower worker help you the first time. I am always willing to help anyone who wants to learn how to safely work on their machine. Experienced tower workers can offer advice and encouragement during this time.

Below: The view is great, but work while you're working and set aside time for sightseeing.

Above: Dan checks the bearings by wiggling the blades in and out.

Servicing your wind machine is a great Sunday project in the spring and fall for the whole family. While you are up there, take in the view, it is spectacular. With a little care and attention to details your wind generator will last for many years. These machines will work their heart out for you if you pay them a little attention.

These are the basics to keeping your life with a wind machine a pleasant adventure.

Access

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Read about Dan's wind system in HP #53, page 6.

World Power Technologies

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SUNELCO

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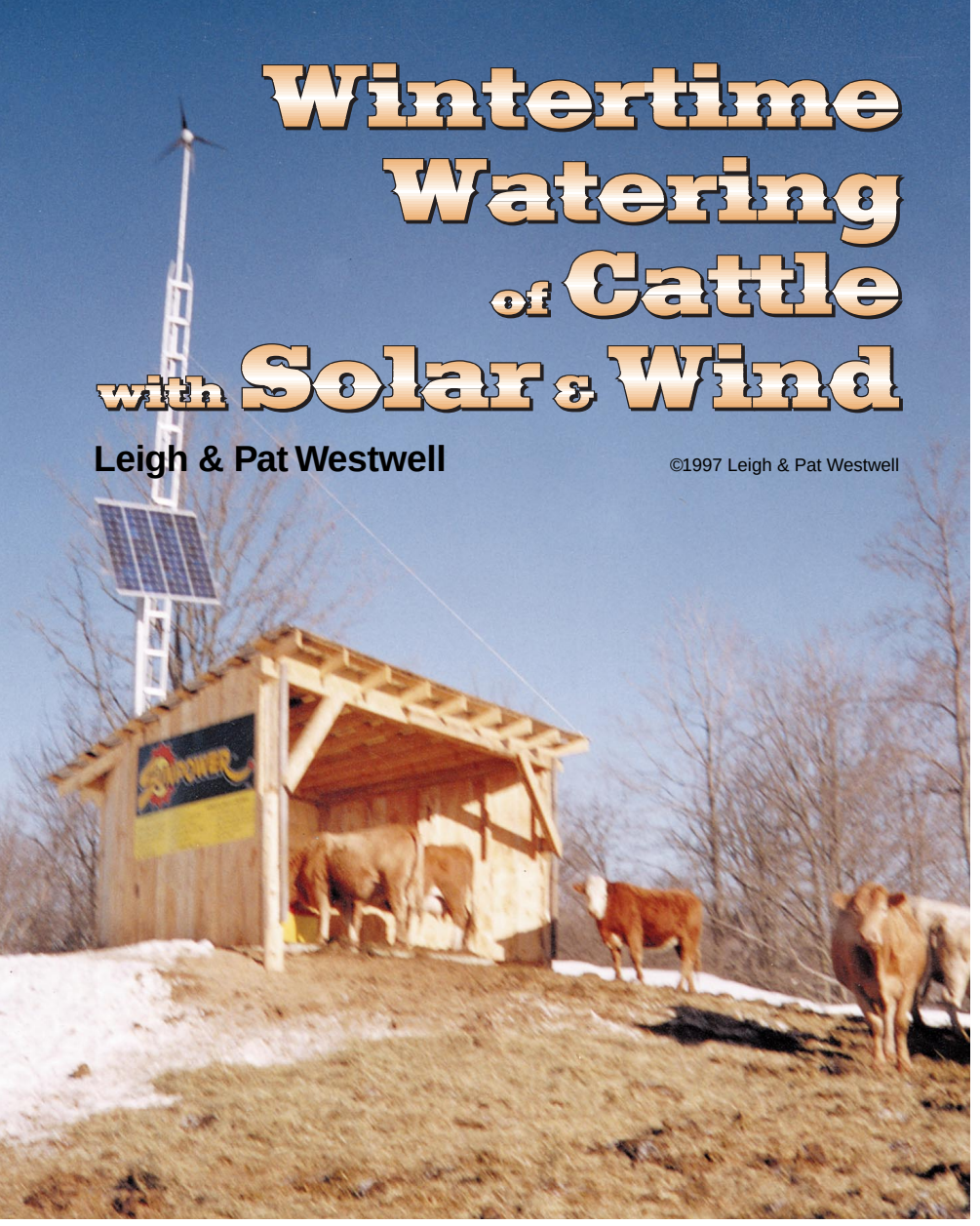
Wintertime Watering of Cattle with Solar & Wind

Leigh & Pat Westwell



This is one of the more interesting projects my wife and I, here at Sunpower in Eastern Ontario, have put together. We have worked with our Federal and Provincial Governments to provide an alternative water sources for livestock through the CURB Program (Clean Up Rural Beaches). This program is designed to entice farmers to fence livestock out of the waterways by funding up to 75% of the fencing cost and providing another water source.

Previously these projects were limited to summer use only, which is relatively easy. When local farmer, Andy Roy, expressed an interest in a year-round system, I did some research to see how feasible this was given our severe winters here in the "great white north." My investigations were discouraging. Local farmers had tried insulated water bowls and had them freeze. Recommendations from one of our suppliers involved a propane heated building with large mud flaps on the doorway which the cattle could push aside to enter the building and access the water bowls.

Our own self-designed and constructed home is buried 15 feet into the south side of a hill in a V shape to utilize ground heat and funnel in sunlight. Ground temperature below the 4 foot frost line is around 50˚F year round, regardless of the outside temperature. In the winter if the sun is shining the house heats itself. I figured that by using the same principles, ground source heat and sunshine, we could make this water pumping station work.

Part of ensuring that the water in the bowl did not freeze was determining the water temperature in the well. Without access to a high-tech temperature sensor, as used to find

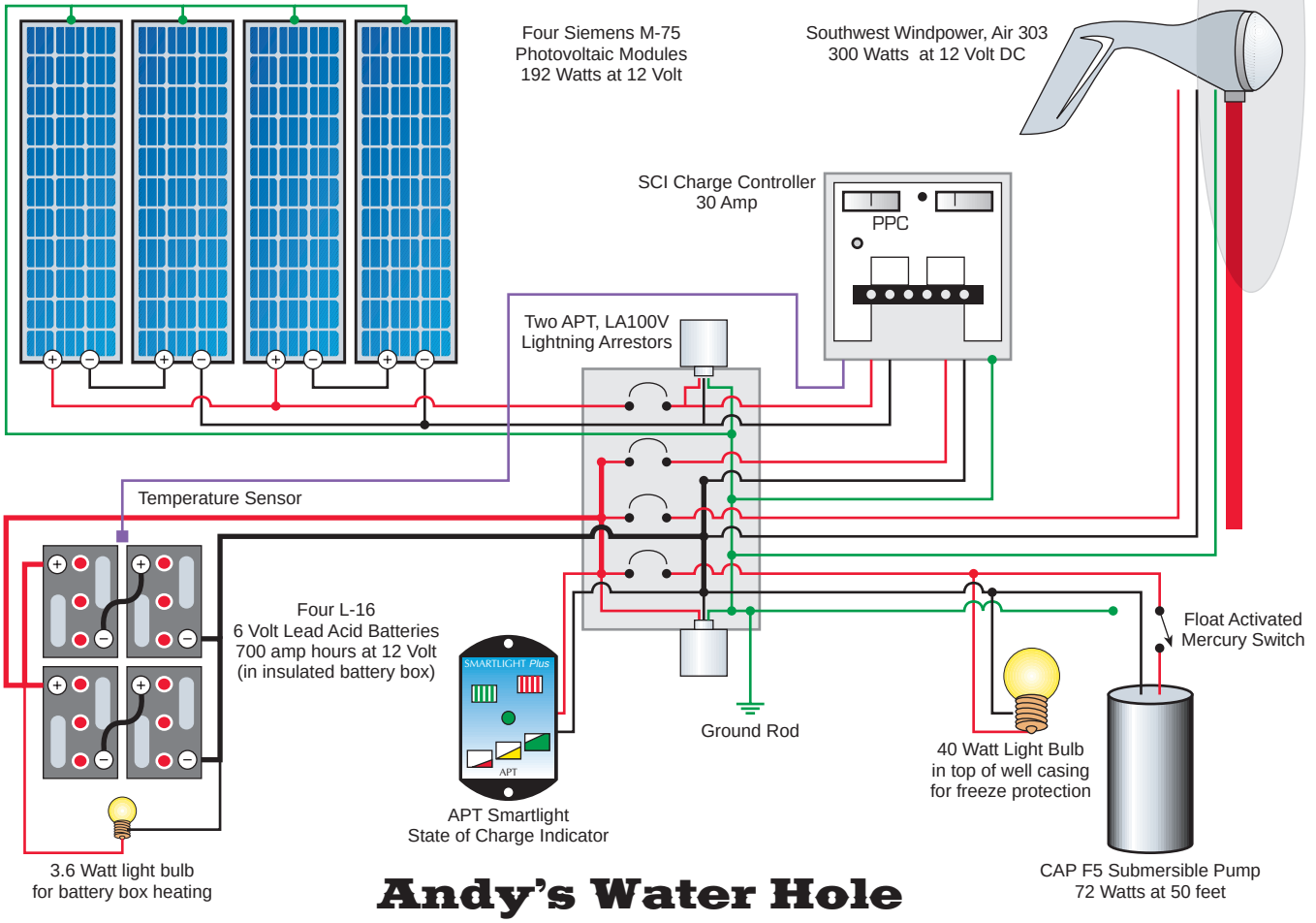
Below: The well head is visible in the center of the soon to be poured concrete slab foundation.

thermoclines in lakes, I used a thermometer in a weighted can with small holes in the bottom. I left the unit at the depth the pump would be (50 feet) and letting it sit for a bit. I pulled the can out quickly so that the water would not leak out the small holes in the can by the time I could read the thermometer. We did several tests and found the water temperature to be around 48˚ F. This seemed acceptable because we were worried that if the water was any colder that it would freeze in the tank if the cattle did not drink for a few hours. Part of the design was sizing the water bowl so that when the livestock were drinking a good percentage of the water, warmer water replaces the colder water in the bowl regularly.

At this point we approached the government agencies funding the CURB Program. They were very interested because they had been having problems getting the farmers interested in the program even with 75% funding. (Rule #1 of farming—don't spend any money!). We designed a system that would have all of the "bells and whistles" so the agencies could show farmers that alternative energy works! Hopefully more will see applications for their own farms and help to clean up our creeks and rivers.

The project began by adding fill around the old well casing so that we had 6 feet of dirt before bedrock. We installed a 6 foot insulated tube around the casing and 2 inches of board type insulation around the top where the water bowl would sit. A 3 inch reinforced concrete pad was poured for the building to keep runoff away from the well. Andy produced the lumber for the building on his sawmill. We bolted the building securely to the pad and buried the front posts deeply to keep the south facing open end from catching the wind.

The pitch of the roof was designed to let in maximum sun in the cold months when the sun is low in the sky. As the weather warms and the sun rises in the sky, the inside of the shelter is shaded and will keep the water cool and fresh. Another function of the building is to shelter the water bowl from the cold winds of winter. The temperature might be -20˚F but a stiff breeze could lower that to -60˚F. Nothing stays unfrozen for long then. The weather is not that bad very often but once frozen it is a long time until spring to be without water. Fortunately, our coldest days are sunny and clear (no clouds to keep the heat down near the earth) and the sun keeps the shelter quite comfortable, especially when combined with ground heat from the well itself as



Above: The insulated battery box, breaker box and charge controller inside the battery room.

the water replenishes. We did install a 40 watt light bulb for heat in the water bowl in case of emergency but it has never been needed. It could be handy if the cattle had to be moved.

We separated the solar electric fence equipment that keeps the cattle out of the Little Skootamatta River from the water pumping station. The reasons were that if the fencer fails, the cattle will still stay around the building for the water, and that if there is a failure in the pumping station the fencer will continue keep the cattle in. The Solar Striker fencer will handle 5 miles of single strand wire and run for 15 days with no sun. It is simple to install. Just drive a ground rod on an angle facing south and strap the fencer unit to the rod. One wire goes to the ground rod and the other to the fence.

We have some pretty bad weather for alternative energy in December and January so we have provided lots of battery storage. When it is dull for days on end the tracker sure helps. It is during times like this that the wind generator does its part to ensure the batteries are fully charged because during cloudy, dull days there is usually wind.

I put a very small fuse-protected light bulb (a dash light drawing .3 A) in the battery box to keep the batteries warm and also to prevent temperature swings which can cause condensation and corrosion. Hydro Caps have eliminated an elaborate venting system for the battery box and because things on most farms do not tend to be serviced unless they are broken, they should lengthen battery life by keeping electrolyte levels up.

I drilled a 3/8 inch hole in the battery box lid and inserted the temperature compensation sensor probe from the charge controller. The other necessary wires exit the battery box through a hole mid way up the back and are siliconed in place to plug the hole and prevent chafing. I put an APT Smartlight just inside the door of the components section of the building so that battery status can be determined at a glance.

The site is fairly high with an excellent view from the top of the wind generator tower. So just in case of lightning I put 90˚ bends in the wires coming down the tower. Lightning should come out of the wire and go to ground rather than make the abrupt turn. An APT Lightning Arrestor is also in line. Each component is protected by an appropriate size Square D breaker so we can isolate every part of the system.

The water pump is made here in Canada by CAP and there are several things I like about this particular 12 V deep well submersible. It is easily serviceable to

System Component Costs

#	*Component*	*Cost*	*%*
4	Siemens M75 PV modules	$2,040	24.1%
1	Ritchie insulated water bowl	$1,000	11.8%
1	F5 deep well pump	$995	11.7%
1	American SunCo Suntracker	$935	11.0%
1	Air 303 wind generator	$895	10.6%
4	UL 16 deep cycle batteries	$880	10.4%
1	SCI 30 Amp regulator	$299	3.5%
1	Solar Striker Fencer	$269	3.2%
	wire, cable and ground rod	$202	2.4%
3	Richie thermal tubes	$192	2.3%
2	APT lightning arrestors	$189	2.2%
80	feet of submersible cable	$132	1.6%
12	Hydrocaps	$120	1.4%
1	APT Smartlite	$90	1.1%
2	mounting poles	$80	0.9%
1	six breaker box	$60	0.7%
4	battery interconnect cables	$58	0.7%
2	30 Amp Square D breaker	$27	0.3%
1	15 Amp Square D breaker	$9	0.1%
	Total system cost	$8,471	

Above: Sans cows, the insulated water bowl is built directly over the well head.

replace diaphragms, etc.; there is a magnetic coupling in the motor so if the pump jams, the motor can still spin and not burn out; if the diaphragms fail the pump will not flood and ruin the motor; and it is made in Canada (Canadians do not wave their flag near enough).

The Ritchie water bowl is super-insulated and has floating insulated balls that seal the water surface so that no water is exposed. The cattle push the balls down with their noses to get the water when they drink. We replaced the mechanical water shutoff valve with a mercury switch on the arm of the float to electrically turn the pump on and off.

I did not want to risk leaving water in the lines above the frost line so I drilled a wee hole at an upward slant in the pipe. This slowly drains the water out of the hose and does not cost much in efficiency. The hole is also below water level in the well so it does not eat a hole in the casing over time.

Previously in winter Andy would water his cattle once a day with a gas powered pump. At -20˚ F he was having some unforgettable memories getting the pump going, chopping ice, thawing lines, and freezing fingers. His cattle would gorge on cold water and stand shivering afterwards and in the summer they would drink run-off water which was sometimes polluted. Now his cattle are healthier and happier and Andy has a couple extra hours per day to do something more rewarding, especially in the winter months. This summer the river is much cleaner without seventy head of cattle polluting it. From little things, big things grow.

Access

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The Biggest Solar Electric Boat this Side of the Mississippi

Steve Cooper

Above: *Rainbow* "motoring" through the marina in Alameda, California.

The Rainbow is a 30 foot sloop weighing 12,000 lbs. Rainbow is powered by a inboard solar electric motor. It has 1,300 lbs of batteries for both energy storage and ballast. To make the boat self-sufficient, it carries 250 watts of solar power. Rainbow is a truly stealthy boat to both motor and sail.

Before Solar

Prior to the boat's conversion, it had a 400 lb, four cylinder gasoline marine engine for propulsion when there is a lack of wind. I experimented with natural gas as a fuel and actually ran the boat on it for awhile but, to my dismay, the engine still had a tendency to leak motor oil into the bilge. That problem, combined with the difficulty of getting my CNG tank refilled, made me decide to get rid of it all and go solar!

Batteries

Seven hundred pounds of concrete & iron punchings which formed part of the poured in place ballast where chiseled out by hand and roto-hammer to make way for batteries. There is a total of 22, six Volt, golf cart batteries on board with six mounted under the floor, six hidden at floor level, and ten hidden in a custom rack inside the engine room.

Power Control

The power control is accomplished via a simple electric relay system out of an old electric fork lift and a Curtis PMC motor controller. Eighteen of the batteries are used to feed the 36 Volt controller which then feeds the drive motor. While the remaining four feed the feed the 12 Volt system.

During the first two years of operation, I experimented with just full on or off operation through relay switching. In other words, I could not vary the motor's speed (rpm). When engaged, the motor was either full power forward or full power reverse. This type of control worked because the propeller acted as a torque converter acts in a car. On motor starts, the power surge is forgiven by the light viscosity of water.

The PWM motor controller has given me much more flexibility in running the boat. It enables me to run the motor for at least 8 hours while still making forward speed. In the past with just relay control, I was doing 5 to 5.5 knots (120–130 Amps) for three hours in no wind conditions and with a clean bottom. Now I am able to cut power back to 3.5 to 4 knots (50–60 Amps) and get the 8 hour range that I had so desperately wanted.

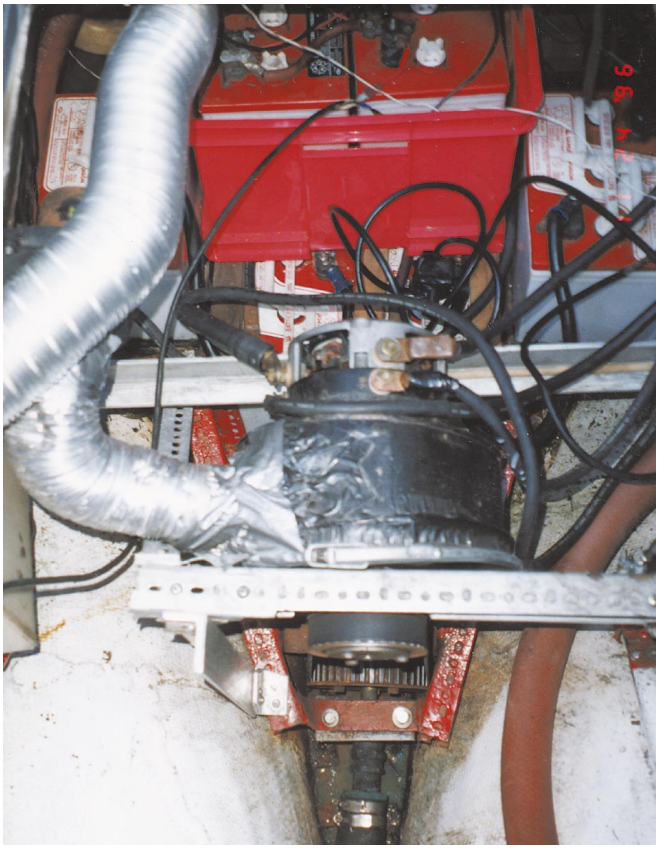
Cooling the Motor and Heating the Cabin

When running the electric motor the whole system tends to get warm. I installed a forced air duct system to cool it, and then I direct this now heated air back into the cabin to keep it warm. At full throttle the air coming into the cabin from the ducted air off the electric motor feels like a hair drier at low speed. This seems to work out well here since San Francisco Bay is always a little chilly.

Photovoltaic Power

The battery charging power for the boat is provided by four Siemens and three Solec photovoltaic modules. This gives me well over 250 Watts of solar power. Perhaps this is not a great amount for direct use but, when you consider the amount of storage and the amount of times I get to use the boat, it adds up to more than enough. Besides, in a pinch, I can still tap into the utility grid at the marina for a fast battery recharge.

Below: Underneath the cockpit lies the 36 Volt Series motor and some of the system's many batteries.



Above: Steve at the helm, ready to cruise as many as eight hours at four knots on one charge.

The 12 VDC System

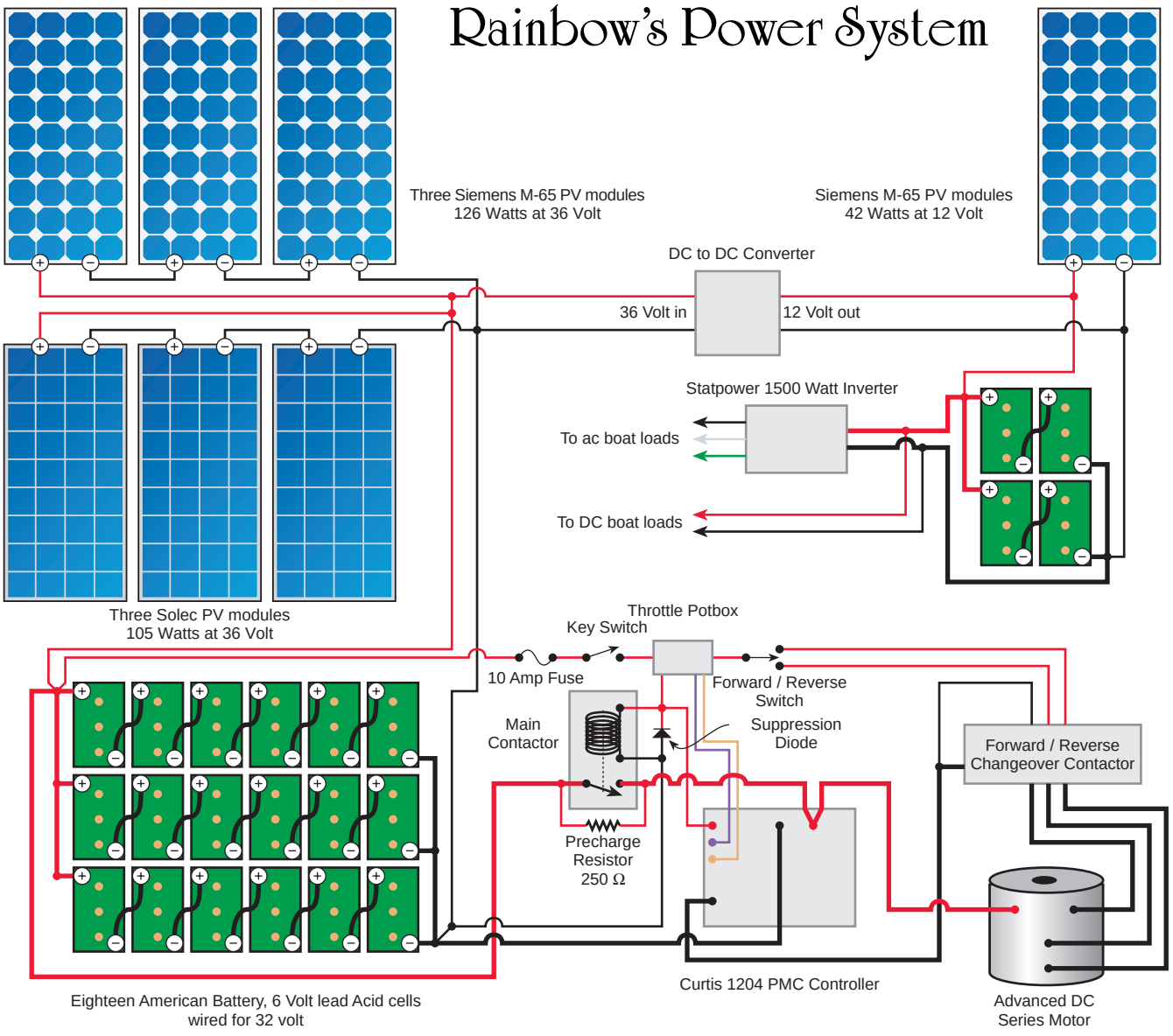
The 12 Volt system is feed power by the one solar panel and by a bleed-over, DC to DC, 50 Watt converter which takes some of the power off the 36 Volt system and feeds it into the 12 Volt one. I can then use 12 Volts to run lights, radios, or TV directly. I can also use 12 VDC to run my 1,500 Watt Statpower inverter powering the rest of my on board appliances such as the microwave oven, refrigerator, espresso maker, and a 486 laptop computer.

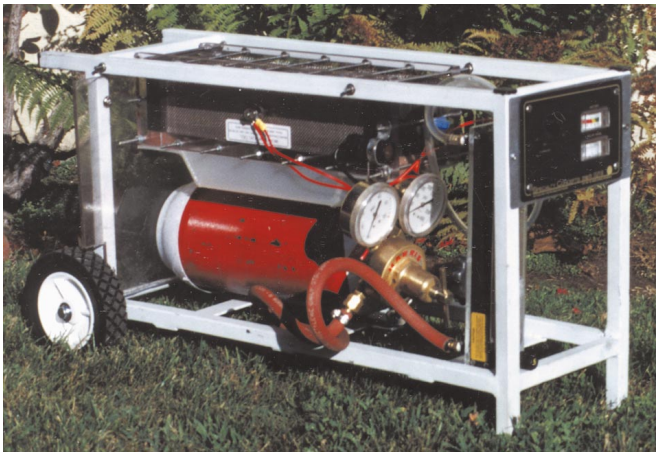
Fuel Cell

For the future I have been working towards getting a hydrogen-powered, PEM fuel cell. I have been working with Warsitz Enterprises in San Jose by helping them to manufacture small experimental fuel cells for

System Component Costs

#	*Component*	*Cost*	*%*
7	PV Modules	$1,550	29%
22	6V Golf cart batteries	$1,078	20%
1	Advanced DC 36 V motor	$500	9%
1	1500 Watt Inverter	$500	9%
	Stainless steel-PV Mounts	$400	7%
1	PWM Motor Controller	$350	7%
	Battery racks	$300	6%
150	feet 1/0 welding cable	$300	6%
1	DC to DC converter	$200	4%
3	Used forklift contactors	$200	4%
	Total system cost	$5,378	





Below: Steve's hydrogen fuel cell waiting to be integrated into *Rainbow*.

educational use. With a larger fuel cell, I could get better energy density than with a lead acid battery. This would allow me to utilize electric propulsion over much greater ranges. I have already gotten enough power out of a 50 Watt fuel cell to power my electronic fish finder, 5 inch color TV, or the small 12 Volt electric trolling motor out of my dingy.

Access

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Web site: http://www.slip.net/~h2man

Where and How to Mount PV Modules

Richard Perez and John Drake

A good solar site is easy to recognize. It is the not–so–good sites that are difficult. What every solar system needs is *all the sun it can get*. A good solar site sees the sun come up at dawn and sees it go down at sunset. A good solar site faces *South*. A good site directly sees the Sun all day and is unobstructed by mountain ridges, hills, trees, or buildings.

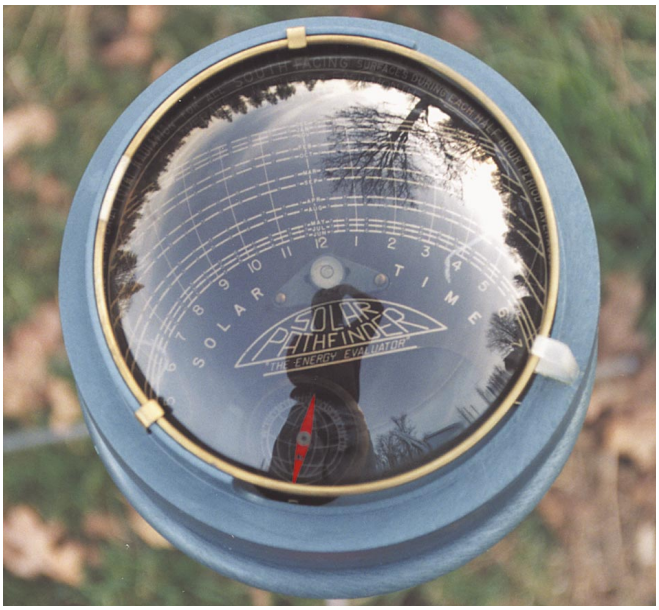
Surveying for Solar Power

If your site has dawn to dusk direct sunlight, then you're in and need to survey your solar no further. All you need is an accurate compass to face your PV array directly SOUTH. Be sure to figure in the difference between magnetic North and true North for your location. This difference between compass North and real North is known as "magnetic declination". For example on the West Coast of the USA, magnetic North is about 19° East of true North. Check a topographic map of your area if you don't know your local magnetic declination, it's printed on the map.

While all day sun is what we all want, few sites actually have totally unobstructed access to direct solar radiation. Then a solar site survey becomes a war of attrition. Each obstacle preventing the Sun's rays from directly falling on the solar face must be located and its effects quantified.

Exact placement of a PV array is critical. Move the array a few feet and the yearly total amount of solar radiation changes. Determining exactly how much solar energy a specific location receives throughout the year is not easy. And to further complicate things, the Sun's apparent angle keeps changing with the seasons. This means that obstacles that don't shade the array in the Summer may do so during Winter.

The array needs to be located at that one specific place on a site that receives the most sunshine. The Solar Pathfinder is THE tool for this job. It takes all the guesswork out of predicting how much sunshine the array can receive, at a specific site, throughout the year. The Solar Pathfinder is easy to use and accurate enough to measure changes in array position down to a few feet.



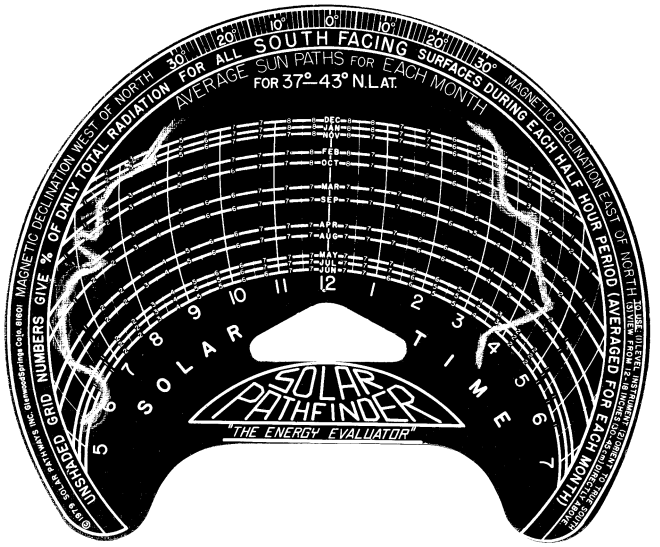
The Solar Pathfinder

The Solar Pathfinder uses a highly polished, transparent, convex plastic dome mounted on a platform containing a compass and a bubble level. Reflected in this dome, the user sees a panoramic view of the world around him. All the obstacles to direct sunshine are plainly visible as reflections on the Solar Pathfinder's polished dome. Since the dome is transparent, the user can also see the sun chart within the Solar Pathfinder. This chart shows details of the Sun's path for every month of the year. The sun chart is also calibrated by the hours of the day.

The dome has slots in its sides and the user traces the outline of the horizon's reflection on the dome onto the sun chart. The traced line shows exactly at which hours of the day, and months of the year, that an obstacle will shade the PV array. From this information we can predict the maximum array performance at any time of the year. The Solar Pathfinder can be used anytime of the day, anytime of the year and in either cloudy or clear weather. In fact, we found it easier to see the reflections in the dome when it was overcast, at dawn, or at sunset.

We ran sun charts for many different locations around our site and compared the amount on sunlight received at each. By doing this, we were easily able to select the best place to put our ground-mounted array. And I mean down to the last foot! No guesswork, no "Well, it looks to me…", just the straight and accurate facts. Shown below as an example is the sun chart of our PV array's site at Agate Flat.

Cost for the Solar Pathfinder is $216 shipping prepaid in USA. This includes a metal case, tripod, an extensive instruction manual, and a plethora of sun charts for all latitudes. Considering that PV arrays can cost thousands of dollars, the Solar Pathfinder is inexpensive because you can put the array in the just right place to get its maximum yearly energy output.



Get a Grip!

This rest of this article explains how to mount your PVs. This is in response to very many reader requests for this info. So, all you PV modules languishing under beds, relaxing in closets, and vacationing in garages: Listen Up, here is your chance to get your people to put you in the Sunshine to do your thing.

Mounting Racks—your PVs hold on the World

The obvious purpose of the rack is to attach the panels to a fixed surface. At first glance this seems simple enough, but consider wind, snow, falling ice, and temperature variations, not to mention possible leaks in a roof!

We are going to talk about a simple to build rack that can hold up to four panels. This rack uses inexpensive hardware store parts. It mounts on roofs, walls, or on the ground with the appropriate foundation. In all mounts, the rack is adjustable for panel elevation, and allows seasonal optimization of the rack's tilt.

The Rack Materials

The most common metals available for PV racks, in descending order of effectiveness, are: stainless steel, aluminum, galvanized steel, structural, and mild steel. Don't use wood to mount PV modules.

Stainless Steel

Stainless steel is the king of materials in most environmental situations. On exposure to the air it forms a tenacious chromium oxide layer which gives it its stain-less qualities. For drilling into stainless steel it is best to use low speeds, a cobalt bit and plenty of cutting fluid.

Aluminum

Aluminum is most commonly used in commercially available structures. These are usually anodized, which is an intensive conversion at the surface to aluminum oxide (same material as in most grinding wheels) in an electrolytic process.

If you choose to use un-anodized aluminum, especially near salt water, use a marine grade of the 5000 or 6000 series alloys. High levels of air pollution or acid rain can also degrade the integrity of aluminum structural members. As a rule most anodized coatings are effective within an environmental ph range of four through nine.

Galvanized Steel

Galvanized steel is a good choice if you are not near salt water or in a high pollution area. The coating, usually a zinc alloy, sacrifices itself to the steel member.

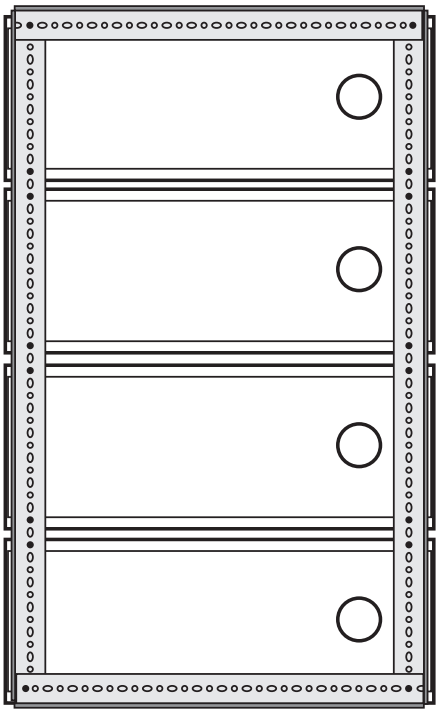
In a mild environment it can last for years.

Structural or Mild Steel
Structural or mild steel is the last choice because they offer little corrosion resistance. Steels are very susceptible to corrosion damage because the oxides that form on the surface do not bond to the metal underneath. They continually flake off and expose fresh metal to the elements.

Fasteners
If it is not stainless steel, do not use it. Do not mix stainless and non-stainless steel fasteners together. When purchasing stainless fasteners your best bet is to buy from a fastener distributor. Hardware stores and marine supply centers will usually charge more (sometimes they have to), not have the item in stock, or know nothing about it. If in doubt as to whether a fastener is stainless, check it with a magnet. Except for some 400 series stainless, a magnet is not attracted to stainless steel.

Home Power's home-made racks
Our racks are constructed out of slotted, galvanized, steel angle stock. This stock is available at most hardware stores. Our local store sells National Slotted Steel Angle (stock #180-109) for about $12.00 each, retail. This stuff is 6 feet long, with two perpendicular sides each 1.5 inches wide. The stock is about 1/8 inch thick, with a heavy galvanized coating. Its entire length is covered with holes and slots that will accept 5/16 inch bolts. We have had no problems with corrosion or electrolysis with this galvanized stock after eleven years in the weather. We haven't yet tried this material on a seacoast, but we expect corrosion could be a problem. If you live in a salt or corrosive environment, then consider using anodized aluminium or stainless steel angle instead of galvanized steel.

You can shop around locally, and may encounter different sizes and lengths. Six foot lengths are long enough to mount three of just about any type of module. We use this angle on BP, Kyocera, Siemens, Solarex, UniSolar, and Solec panels without having to drill any holes in either the angle or the PV modules. Working with this stock is like playing with a giant erector set. The only tools you really need are wrenches, a hacksaw (to cut the angle), and a drill for making holes in the surface holding the rack.



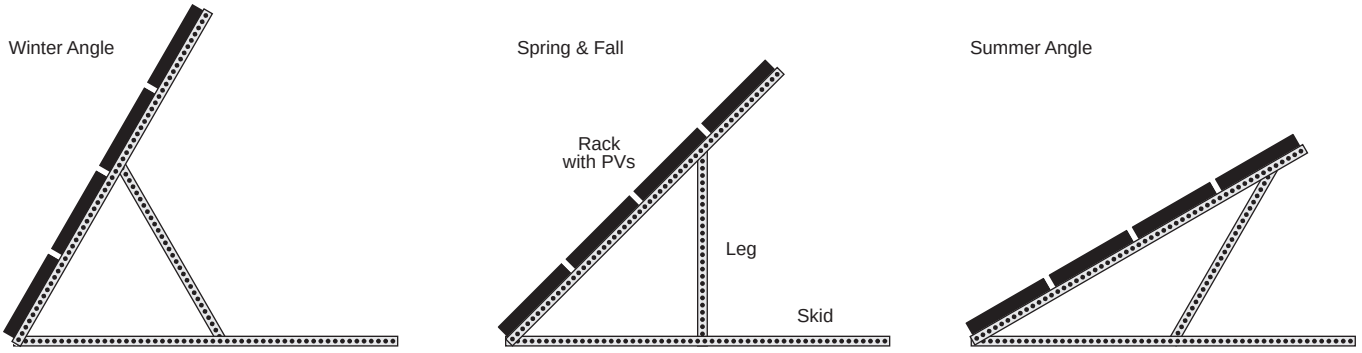
The amount of steel angle stock you need depends on the size & number of panels you wish to mount, the mounting location, and your particular environment. Let's consider the rack shown in the photo in the introduction photo.

This rack holds four 48 Watt Kyocera PV modules. Each PV module is 17.4 inches wide and 38.6 inches long. The mounting holes on the bottoms of the PV modules match the hole cadence in the slotted angle. This particular rack used nine of the six foot lengths of the steel angle. Four lengths comprise the framework for the modules. Three lengths make up the legs and bracing, while two more lengths are used as skids on the roof. Strictly speaking, the skids are not essential, but do add rigidity. We don't want any leaks.

A rack could be built with about half the materials. The top and bottom pieces of the rack holding the panels, the brace on the legs, and the skids could all be deleted. If this were done then the rack would be roughly equivalent to many commercial models. Many commercial racks use the PV modules' frames as structural members in the whole module/rack assembly. This rack does not do this.

This rack lives in snow country, with lots of high winds. Consider that the rack holds some $1,400. worth of PV modules. We figured that the additional $48. the extra bracing costs to be worth it in terms of security. It's comforting to be inside during a howling snow storm and know that when its all over the PVs will still be there. Don't skimp on materials for your rack. Use extra bracing to make it as strong as possible. Remember that it holds over a thousand dollars worth of PV modules. The nine pieces of slotted angle cost us about $108., and are well worth it.

Laying Out the Rack
You could design the entire rack on paper after first making all measurements of the critical dimensions on the modules. This takes time, and is subject to measurement inaccuracies. We have a simpler idea, with no measuring required. Let's treat the entire project like an erector set. We assemble the entire rack on the ground first, even if it must be disassembled to be finally installed. This assures no surprises upon final installation.



Lay a thick blanket or sleeping bag on a flat, smooth surface. Place all the modules, face down on the blanket and lay on the side angle pieces that connect the panels.

Note that no measurement is required. Simply align the mounting holes in the module frames with the holes on the angle. We usually leave any extra angle on these pieces, rather than trimming it off. It comes in handy. On this particular rack the four Kyocera modules mounted perfectly, with no trimming of the six foot side rails necessary. The distance between the mounting holes on the modules determines the width of the rack.

Cut two pieces of angle to form the top and bottom to the rack rails. These should be trimmed exactly to fit inside the framework created by the side rails. The net result is all four panels are encased by a perimeter of steel angle. Use stainless steel, 1/4 inch bolts about 1 inch long, washers, lockwashers, and nuts to secure the modules to the framework. The bolts on the corners of the framework go through the module, the side rail, and the top (or bottom) rail. The result is very strong.

If you don't fully populate the rack right now, you can use several pieces of angle stock in place of the missing panels. I strongly recommend building the three or four panel version. If you don't, then system expansion is going to be harder. Also building a smaller rack costs about as much when the waste on the 6 foot lengths of angle is considered. So build for the future, and see how easy it is to add a panel or two once their rack is already in place.

The Skids

I usually leave the skids in uncut six foot lengths. The skids form the base for roof, wall or ground mounting. If the rack is to be wall mounted the situation is much the same except the skids are vertical instead of horizontal. In all cases, one end of the skid is connected directly to the module frame rails by bolts. This forms a rotating hinged point for rack elevation adjustment.

The Legs

The actual length of the legs varies depending on where the rack is mounted, your latitude, and whether or not you want adjustability. The slant or pitch of a roof

Leg length in inches for various latitudes and mounting surface angles

Mounting Surface Angle in Degrees

LATITUDE	0	5	10	15	20	25	30	35	40	45	50	55	60
60	72	66	61	55	49	43	37	31	25	19	13	6	0
55	66	61	55	49	43	37	31	25	19	13	6	0	6
50	61	55	49	43	37	31	25	19	13	6	0	6	13
45	55	49	43	37	31	25	19	13	6	0	6	13	19
40	49	43	37	31	25	19	13	6	0	6	13	19	25
35	43	37	31	25	19	13	6	0	6	13	19	25	31
30	37	31	25	19	13	6	0	6	13	19	25	31	37
25	31	25	19	13	6	0	6	13	19	25	31	37	43
20	25	19	13	6	0	6	13	19	25	31	37	43	49
15	19	13	6	0	6	13	19	25	31	37	43	49	55
10	13	6	0	6	13	19	25	31	37	43	49	55	61
5	6	0	6	13	19	25	31	37	43	49	55	61	66
0	0	6	13	19	25	31	37	43	49	55	61	66	72

is another factor that determines the length of the legs. Let's consider the simplest case, that of mounting on a flat roof or on the ground. In this case the skids are horizontal and level with the ground. Figure 4 illustrates the geometry of this situation for adjustable racks for latitudes around 40°.

In the adjustable rack at 40° latitude, the legs are 49 inches long. Altitude adjustment is accomplished by unbolting the legs and repositioning them along the rack rails and mounting skids as shown in Figure 4. These legs allow adjustment of the angle between the rack's face and horizontal from 32° for Summer use, to 57° for Winter use. Four adjustments yearly will increase the PV output by about 10%. This is really not a very great increase in performance, but the modules are already paid for and it beats running the genny in the winter. I think that a 10% increase in our PVs performance is well worth the four times yearly expenditure of 15 minutes of our time to adjust each rack.

On roofs that are not horizontal (and most aren't), the legs get shorter as the roof gets steeper. A good overall, nonadjustable, mounting angle is your latitude. If you live at 40° latitude, then mount the rack so that the angle between the rack's face and horizontal is 40°.

The table on page 35 shows the proper leg lengths for South facing roofs and a variety of latitudes. This table assumes the use of 6 foot rack rails and skids. The top of the table contains roof angles from 0 degrees (flat) to 60 degrees from the horizontal. The left side to the table shows latitude in five degree increments. The actual leg lengths in inches are in the body of the table. This table is based on legs which can be bolted anywhere along the rack's face and along the skids. The legs are long enough to provide a steep wintertime angle, and are also short enough to allow the rack to be tilted back during the summer. We usually attach one leg end to the skid about 2/3 of the distance from the hinge. We then adjust the leg's position on the rack four times yearly.

Note that this table shows leg length decreasing as the roof's angle approaches the latitude. Once the roof's angle becomes greater than the latitude, the legs are attached to the bottom of the rack rather than the top. Instead of raising the top of the rack to face the Sun, we raise it's bottom.

If you're into math, the formula used to generate this table is based on the Cosine Law. Here is a solved and generalized equation that will give leg lengths for all situations regardless of rack or skid dimensions, latitude or roof angle.

$$L = \sqrt{R^2 + S^2 - 2RS \cos(A-P)}$$

L= length of the Leg in inches

R= length of the Rack in inches

S= length of the Skid in inches

P= the angle of the roof's plane to the horizontal in degrees

A= your latitude in degrees

The geometry is much the same for wall mounting, but the skids are vertical. In any case, don't be afraid to mount the skids however you must, adjust the rack's elevation, and cut the legs to fit. This approach, while low tech, gets the job done every time.

Mounting the Rack on a Roof

A roof is a difficult place to do a good job. I prefer ground mounting of PV modules. The steeper the roof, the more difficult the installation. On steep roofs I like to assemble the whole rack, complete with PV modules (already wired together), legs, and skids on the ground. Then transfer the whole assembly (about 70 pounds) to the roof for final mounting. We have successfully used the skid mounting technique on metal, composition shingle, composition roll, and shake roofs from 15° to 45° of pitch.

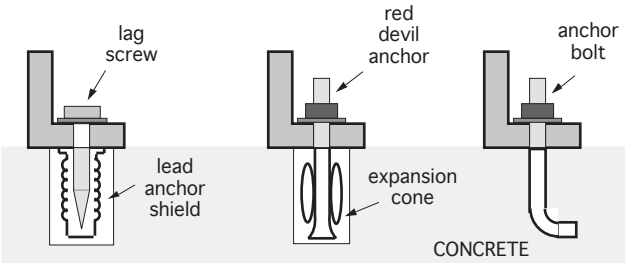
Don't mount the PV modules themselves directly on the roof's surface. PV modules require air circulation behind them to keep them cool. If you are blessed with a roof pitch that equals your latitude and a South facing roof, please resist the temptation to mount the modules directly on the roof. The high Summer temperatures underneath the modules will greatly reduce their performance and can cause the PV modules to age prematurely. So leave at least 3 inches behind the modules for air circulation. Keep it cool!

Use at least four bolts (5/16 inch diameter) to secure the skids to the roof. Use large fender washers inside the roof, and lockwashers on the outside. Liberally butter the entire bolt, washer and hole in the roof with copious quantities of clear silicone sealer. When everything is tightened down and the silicone sealer has set, we have yet to have any problems with leakage.

Ground Mounting

If you are ground mounting, take care to pour or bury a massive cement foundation for securing the skids. Ground mounting exposes the PV modules to all sorts abuse. They may be hit by everything from baseballs to motor vehicles. So pick your spot wisely, and provide lots of mass to hold the rack to the ground. Cement blocks, or poured cement strips are best. The most

readily available mounts for wet concrete would be “el” shaped anchor bolts. For existing concrete you may use either lead shielded anchors (with lag screws) or the “red devil” type. With the “red devil” types you can drill and insert the anchors through the mounting pads in place.



Commercially Made Racks

If you don’t want to build your own PV mounting racks, then there are many companies which commercially produce these racks. Use the info about rack geometry, metals, and hardware presented here to determine which rack to buy. Use the information about the ground or roof interface to determine if your installing dealer is doing the job right. If you are not really handy with tools, then buying a factory-made rack for your modules is more cost-effective and time-effective than building your own. If a dealer is siting your array, then be sure to get a copy of the Sun Chart for your array’s location. If your dealer doesn’t do Sun Charts, then fire him and get another.

Trackers

If your site survey shows dawn to dusk sunshine throughout the year, then you have a site for a PV tracker. Trackers follow the sun’s apparent motion and can provide up to 40% more yearly energy from the photovoltaics mounted upon the tracker. At this point in time, it is cost effective to track eight PV modules. This means if you have (or need) eight or more modules, then it is more cost-effective to track the existing eight or more PVs than to buy additional modules. Here at Home Power, we have five sub-arrays. Three of these sub arrays are tracked, two are stationary south-facing arrays and are angle adjusted four times yearly. We have printed our sun chart here. In our location, tracking is definitely cost-effective.

Access

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TRACE ENGINEERING

b/w

full page

on negative

this is page 38

Closing the Solar Cost Gap with People Power

John Schaefer

The whole planet is no less our home than the building we live in. Evidence suggests that the Earth's climate is already changing and that the changes are probably due to the carbon dioxide (CO_2) with which humankind pollutes the atmosphere.

An April 1995, "Science" article by Bell Labs statistician David Thomson showed that climate change measurably different from historical patterns began in 1940. Later, the United Nations Intergovernmental Panel on Climate Change was reported to be "now more confident than before that global climate change is indeed in progress and that at least some warming is due to human action, specifically the burning of coal, oil and wood…". And the January 1, 1996, New York Times reported that 1995 was the warmest year on record. Figure 1 shows recent CO_2 emissions and temperatures. On the other hand, the carbon-burning lobby keeps saying no action is necessary unless climate change is proven.

The only way to arrest global climate change is to reduce CO_2 emissions. World governments agreed at the Rio conference in 1992 to do so, but their target of reductions to 1990 levels by 2000 may be insufficient. In any case, it will not be met. Neither corporations nor governments have taken effective steps to reduce emissions.

Solar power sources = pollution-free electricity

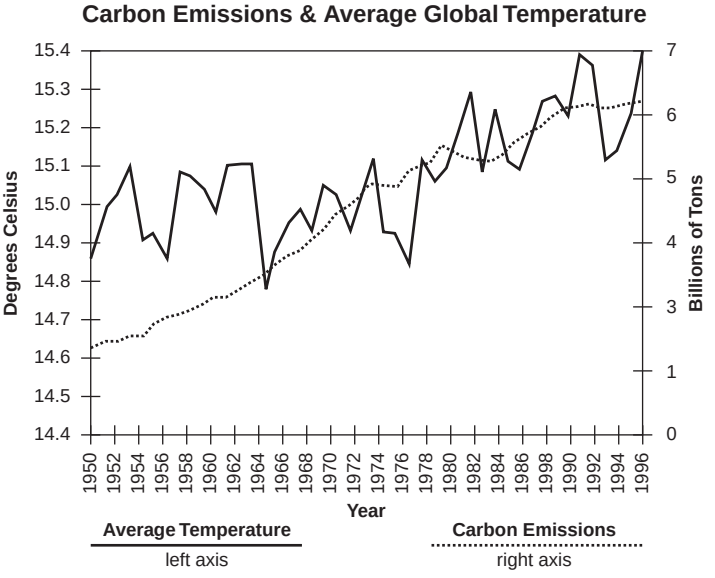
CO_2 emissions could be reduced markedly by widespread use of solar and wind power, but they now supply only about .2% of electricity in the U. S. We have a long way to go, but the land area in a single large county like Nye County, Nevada could supply all the electricity the U. S. now uses, even with today's 10% efficient solar technology. Technically, the entire planet can be supplied with solar electricity.

It's easy for individuals to say, "There's nothing I can do about that," but if corporations and governments won't do it, the only ones left are individuals.

Technical, economic, and institutional constraints restrict solar's wider adoption. Solar electric technologies turned out to be more complicated than we thought a decade ago, and are also more costly to develop and sell. The reliability, efficiency, and longevity essential to commercial success were elusive, but they have now been successfully demonstrated. Electricity storage methods will eventually be necessary for dark periods, but there is already enough storage hydro in the U. S. that solar and wind can supply a major portion of U. S. electricity without technical problems. Geothermal, biomass, hydro, and landfill gas will be needed too, but they face the same problems solar does.

Pollution-free power sources are too expensive for the grid

Besides wind, four technologies offer cost-effective, solar power potential. They are central receiver solar thermal, parabolic trough solar thermal, dish Stirling solar thermal, and photovoltaics.



Source: Compiled by Worldwatch Institute from G. Marland et al., "Global, Regional Production, and Gas Flaring: 1950-1992" (electronic database) Oak Ridge, Tenn.: Oak Ridge National Laboratory, 1995); Worldwatch estimates based on Marland et al.

Status and Costs for Solar and Wind Technologies

Technology	*MW on line, USA*	*Minimum Scale*	*Technology Status*	*Observed Cost $/kWh*	*Possible Future Cost $/kWh*
Wind	1700	300 kW	mature	$0.06	$0.04
Parabolic trough	354	80 MW	R & D on hold	$0.09	$0.06*
Central receiver	10	10 MW	experimental	$0.81	$0.10
Dish Stirling	0.1	7.5 kW	experimental	$0.47	$0.07
Photovoltaics	10	50 W	silicon mature, others experimental	$0.28	$0.09

* Integrated solar combined cycle gas (hybrid)

Amortization of the initial investment forms the largest cost component for solar electricity. For example, a PV system owner who invests six dollars per watt, expects an annual payment of 10% on his investment (which covers insurance, taxes, interest and amortization), generates energy with a 25% capacity factor, and pays half a cent per kWh for maintenance will find his cost is 28 cents per kWh generated. Of that, 27.5 cents is the annual payment. Commercial investors like utilities need annual payments closer to 15%, raising their costs further.

The table summarizes these technologies' current status and costs. Observed costs are for equipment now operating. For wind, parabolic troughs, and PV they represent the present state of the art. For central receivers and dish Stirling, there is so little experience that observed cost numbers carry less certainty. Possible future costs are those expected if markets expand so that research and development continues with adequate investment. They are obviously less certain.

Power suppliers choose their investments on the basis of minimum cost. Because of its high initial cost, solar has not been attractive to them. Conventional coal plants now produce energy for internal costs of 3 or 4 cents per kWh. The costs for newer combined cycle, gas fired plants are about the same. It's clear that solar's observed costs, ranging from 5 cents to 81 cents, are too high for wide-scale application.

The solar cost gap

Utilities prefer not to pay more than about 2 cents per kWh on an avoided cost basis to independent power producers. The difference between what solar power costs and what utilities will pay for it is the solar cost gap. If electricity costs a PV system owner 28 cents and a utility will pay 2 cents, then the solar cost gap is 26 cents. Every kWh the owner produces and sells to the grid costs him or her 26 cents. But a surprising number of globally responsible individuals are doing just that. What the world needs are more.

An issue is whether investment will materialize for the research and development (R & D) necessary to drive costs down further. In a world where the promise of profit determines which investments are made, there will have to be a market to offer that profit. Except for wind and PV, both of which have a remote, small scale market, the market doesn't exist now. Will there be one in the future?

Possible future costs in the table are predictions. If R & D investment materializes and costs decline to those levels, will solar compete with fossil-fueled power generation? Wind probably will, as its costs could decline below 4 cents in good locations. But the possible future costs for solar technologies range from 6 cents (also the same for natural gas plants) to 9 cents, still higher than the costs of polluting sources.

People want solar power

All the foregoing clouds a solar future, except for one thing: people want it. This desire isn't based on investment economics but rather a preference for continued survival of humankind and its fellow earthly species. In dozens of surveys and polls, electricity customers have shown their preference for solar and wind power over fossil and nuclear. And regardless of how the survey questions are worded, many respondents say they would pay extra for pollution-free electricity.

Sacramento, California's success with their PV Pioneers program demonstrates not only that people say they will pay more for solar electricity but that they actually do pay more. But the way institutions are arranged now, customers in all but a few utility service territories are prevented from doing so.

This is because as regulated monopolies, utilities are constrained to purchase only the cheapest power. They aren't inherently evil, they're just following the rules that society established for them.

Cracks are appearing in their monopoly armor. Net metering is already available in some states including California (see HP #49 page 82 and HP #48 page 70).

It will increase utilities' effective payment to about 10 cents so the solar cost gap will decline to 18 cents. But net metering is only a small step along the way. There must be something better, but what?

Green pricing and rate-based pricing (see HP #49 page 89 and HP #44 pages 20 and 71) are mechanisms by which a large number of utility customers can each contribute a small amount on their bills, and thereby support some grid-connected solar power. Under green pricing the contributions are voluntary; under rate-based pricing all customers in a service territory or municipality must pay a small amount. The key is that these contributions enable payments to solar producers that cover the actual costs of solar electricity—at least 28 cents now for PV. This level of payment can reduce the cost gap for owners to zero so that a roof top PV system could be a reasonable investment.

How much of a difference would these new pricing arrangements make in solar power generation? If 1% of total U. S. utility revenue were spent for wind and solar power, as several dozen European utilities are doing, it might triple the amount of solar electricity generated.

Does that amount of solar power generation solve the planet's problem? Certainly not, it might increase the U.S. solar and wind electricity fraction from 0.2% to 0.6%. With luck and declining costs it might rise as high as 1%. That's still less than a year's electric load growth, and it would only mean solar falls behind load growth more slowly.

Nevertheless, even though they make a just small contribution to solving the problem, rate-based and green pricing are essential next steps. They will provide several years of steady markets for solar power technologies and, more importantly, they will help bring costs down to the possible future cost shown in the table's right-hand column. Publicized, they will also help the public understand the dimensions of the problem.

Polluters could pay for their damage

Possible future costs in the table still exceed those of coal. And in the absence of public pressure, corporations and others with no concern for humankind's future will continue to burn coal for electricity. At some point, however, society will have to recognize that carbon burning cannot continue. This may happen far in the future, after parts of Holland and the coastal regions of Bangladesh and Egypt are submerged, but it will happen. At that point those who burn carbon will have to be charged for the damage they cause, and then they may stop. What will Holland and Bangladesh and the earth's climate have been worth? Economists call these external costs, but I call them damage costs.

Preliminary estimates of damage costs suggest that they are at least equal to the financial (internal) costs. That would make electricity from coal cost 6 or 8 cents. If those who produce CO2 and those who use the electricity pay for the damage, at least some of the possible future costs in the table will become economic. Private investment may then materialize if investors see that there's a large enough market for solar electricity.

Some will claim that this green pricing and damage cost scenario is science fiction, but it may be the only way to enable the planet's species (including us) to survive. Europeans have already begun examining the scenario and are considering a carbon tax. Although carbon taxes are still unlikely in the U. S., there is hope.

Direct access for renewables

The U. S. utility industry is now being deregulated. Power generation will no longer be a utility's monopoly but will instead be opened up to competition among many suppliers. Restructuring is driven by large industrial customers' desire for cheaper electricity. Part of that change may include direct access, under which every customer, large or small, will be able to choose their own electricity supplier. Any customer could choose pollution-free sources. It will cost more, but if electricity customers are like automobile customers they may not simply choose the cheapest product, but instead choose the best. There will finally be a market for electricity like there is for almost everything else.

California's deregulation process offers hope

California's recent restructuring legislation could enable consumers to purchase pollution-free electricity, but only if legislators are made aware that's what consumers want.

Generation will be deregulated, so that the power plant owners can bid in a daily auction the prices they wish to charge for electricity they generate. Electricity will still be mixed together physically and transmitted over the same wires. But contractually and economically a customer can choose to buy electricity from solar sources, and have it transmitted through the existing grid.

The details are more complicated. Utilities have invested heavily in power plants that are more costly than the new combined cycle gas plants that utilities' competitors wish to build. Customers will pay off utilities' excess ("stranded") costs with a Competitive Transition Charge or CTC.

Renewables could be exempt from the CTC

The new law provides that almost all customers must pay the CTC, with a few exceptions which might include electricity from renewable sources. Moreover, because

utilities wish to be paid off earlier than they would have been under their old regulated status, this CTC would, in the absence of other provisions, effectively raise almost everyone's electricity cost.

But California's legislation also requires that customers' electricity prices be reduced by 10% between 1998 and 2002. If customers have to pay extra for the CTC, how can their prices be reduced? Under the legislation, the California Infrastructure and Economic Development Bank will borrow money at low interest rates using California's good credit, pay off the utilities' CTC, and then repay at a slower rate the Bank's bonds with revenue it collects from customers.

The legislation also provides $540 million to be used to support renewable electricity sources over a four-year period. The California Energy Commission will recommend by March 1997, how that money should be spent. It is deciding now, with suggestions from the diverse sectors of the grid-connected renewable energy industry. Most of the RE industry groups want the money to be used for subsidies so they can sell their electricity cheaper into the newly created Power Exchange. But that may well be the wrong market for renewable electricity generators.

Industrial customers will soon be allowed direct access to the suppliers of their choice so they can take advantage of cheap electricity. In fact, they were the ones who insisted on deregulation. Some parties have claimed that it would be too complicated to offer direct access soon to residential customers, so if utilities have their way residential customers will be obliged for a while more to buy electricity from generation sources the utilities choose.

Renewable customers get direct access

There is an encouraging alternative. The legislation provides that customers will be eligible for direct access if half their electricity is supplied from a renewable resource. Renewable suppliers or brokers have the opportunity to provide residential customers with renewable electricity. If they do, these benefits would accrue to California:

- Some customers would pay the higher costs of RE and be assured that their own electricity was not polluting the planet;
- Those customers might have the satisfaction of knowing they are not paying the CTC for old, uneconomic, polluting power plants;
- The renewable electricity industry can access the market that the polls and surveys say exists;
- Renewable power plant developers will be able to finance their proposed installations;
- Investors might see some prospective profits from research and development in renewable electricity; and
- There is a chance that California could help arrest the rush to global climate change.

One caveat is that consumers must be aware of the pollution that their consumption produces, and be able to compare the real numbers from various suppliers. Conceptually that is easy, and as practical matter it is just a matter of collecting and processing numbers. California certainly can do that.

Let people get on with it

To the casual observer all this seems difficult to accomplish, given the economic, institutional, and political barriers. But in the long run, what other choice is there?

Implementing solar power is not as easy as its advocates thought it would be a decade ago, but it is more crucial now. Decision makers have not responded to today's tragedy of the commons—namely the possible destruction of the climate on which the human species (and most others) depend. If the institutional decision makers don't do it, then it is all the more important that the rest of us promptly take concrete steps to use solar power on a wider scale. Pollution-free electricity may only be possible if institutions get out of the way and let people get on with it.

CEERT in Sacramento offers an e-mail mechanism <http://www.ceert.org/pledgeform.html> to help this take place.

Access

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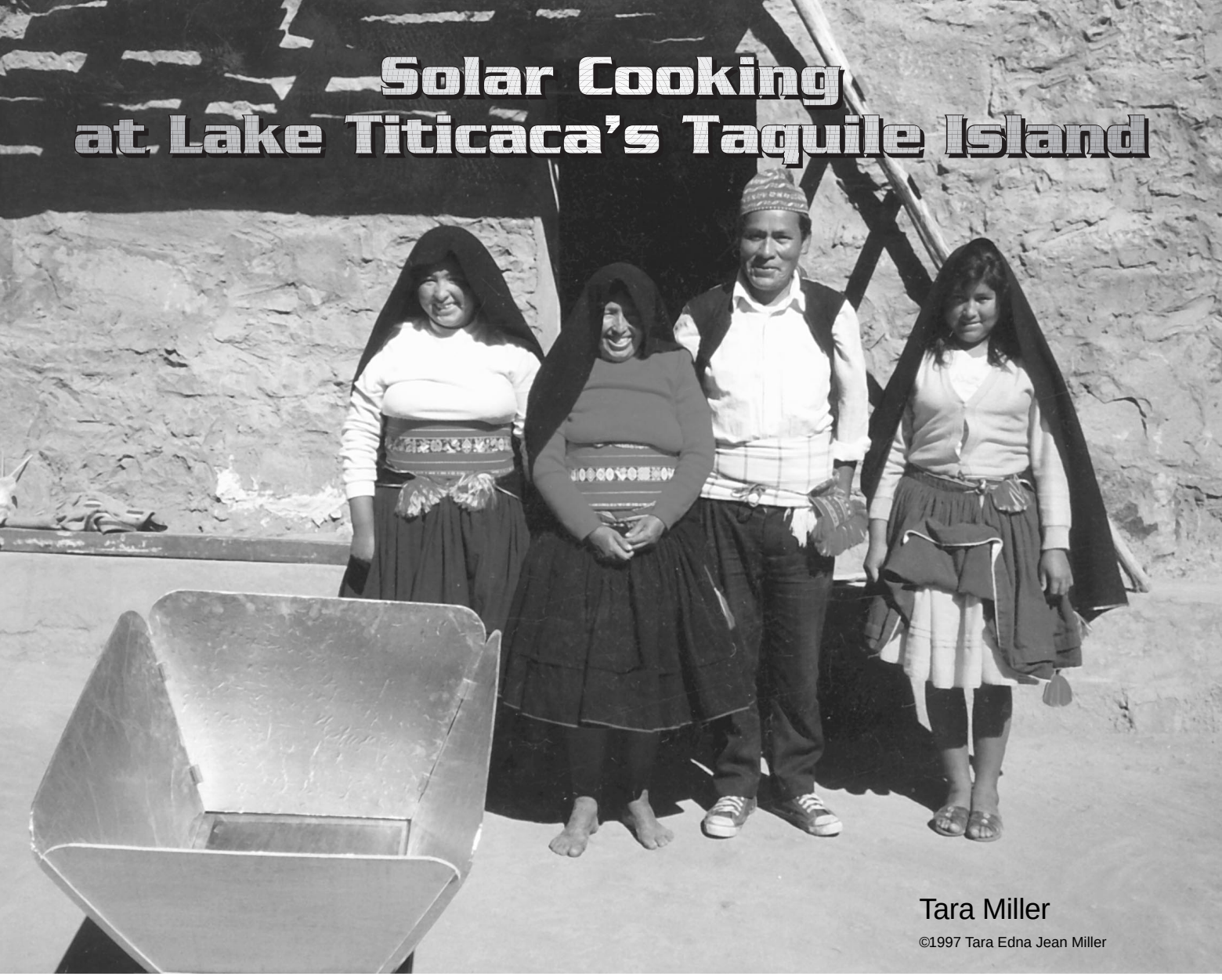
John is starting a renewable electricity brokerage. Anyone interested please contact him.

Solar Cooking at Lake Titicaca's Taquile Island



Tara Miller

Above: Julio Quispe Crúz, with his wife and daughters, in front of the plywood solar cooker he built.

We spent May of 1996, building solar cookers on Taquile Island, on Lake Titicaca in southern Peru. Sam Brown and I taught building designs and cooking techniques over a 5 week period. By the time we left, the island had 10 ovens and 3 carpenters interested in producing ovens for sale.

Lake Titicaca has an altitude of 12,700 feet (3855 meters) with fierce sun. The island is hilly and rocky. The people are strong and resourceful. We first visited the island in 1986, and developed a strong relationship with Felipe Huatta-Crúz and his wife, Celbia Yukra-Huatta.

Strong Community

Taquile has a very strong community structure and their knitted and woven arts are among the finest quality in the world. Early in this century the Peruvian government wanted to expel the residents and turn Taquile into a prison island, but the community united to keep their land. Then in the late 1950's, when motors on boats became common and tourists began to visit, the community united again to oppose construction of a hotel and instead initiated a program assigning visitors to stay in the guest room of an individual family on a rotating basis. An interesting sophistication resides in natives who stay at home but meet visitors from all over the world. Both men and women wear traditional handwoven clothing. Festivals and preparations for festivals are very important. People are connected in a web of reciprocating relationships among each other and even with the mountains and hills. All families are subsistence farmers.

We visited again in 1988, and finally returned in 1996 to visit and expand our extended family relationships in the community. In the meantime in 1991, we had purchased the Sun Oven, a commercially made solar oven. We became enthusiastic promoters of the simplicity and effectiveness of this insulated black box with four reflector panels set at 67˚. We built several ovens over the next few years and taught friends and neighbors to build and use them here in Western Colorado. This sunny climate is ideal for solar cooking, and we use ours every sunny day, all year long. We corresponded with our Taquile friends about the cookers, and when their letters began expressing an interest in these cocinas solares we figured it was time to bring the technology to Taquile. We avoided the rainy season by planning the trip for May.

Demonstrating in the Central Plaza

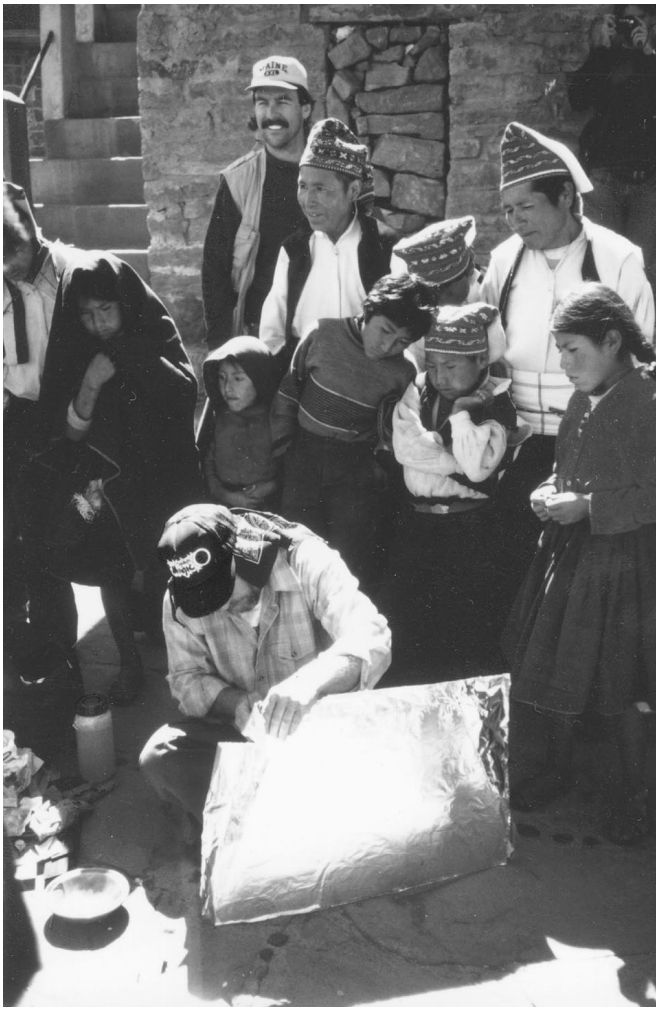
Sunday is community day in the central plaza of the town. That first Sunday, potatoes baked in the Sun Oven while Sam assembled a small cooker of corrugated plastic and cardboard pre-cut parts we had carried in our suitcase. We answered questions and gave away copies of an instruction booklet to people who were really interested in building a cooker. The kilo of potatoes was ready in less than an hour. I passed around tiny tastes to about 100 people who were sitting in the square that day.

Our Spanish language instruction booklet was written by Maryknoll Sister Patricia Gootee and Geovana Quezada Rivera of Arequipa, Peru. We acquired the booklet from Andy McDonald and Mark Schimmoeler, after their article in HP #44. The booklet is not copyrighted. Patricia and Geovana encouraged us to make copies and disseminate them freely.

The Arequipa oven is based upon Joseph Radabaugh's Heaven's Flame and the Wisconsin oven: four panels set at 67˚ reflecting sunlight into an insulated black box.

Available materials differ from in the United States. Two Taquile islanders, Julio Quispe Crúz and Esteban Huatta-Crúz, showed great interest and agreed to build ovens. They accompanied us to Puno on the mainland to buy materials, with the agreement that we would trade the cost of materials for fiber arts later.

The plywood is very thin, three ply and about 1/4 inch thick, which is handy because it is light weight. For the glass we settled upon semi-double, which seems equal to U.S. double strength, but you have to watch out that you don't get tinted glass. Cardboard boxes are not free as they are in the bigger cities, and could be quite expensive. That first day we could not find any aluminum foil in Puno, but later learned that the "Mini Market" carries it at a high price. Black latex paint was also unavailable in Puno, but one hardware store with a very friendly owner had it on order by the end of our trip. We had carried foil, tempera paint, and oven thermometers from the United States. Tempera was available in the stationary stores, but only pre-mixed in tiny expensive containers. We never found an oven thermometer for sale.



Above: Sam Brown demonstrates solar cooker construction in the main plaza of Taquile.

The Improved Arequipa Design

We left Julio and Esteban with enough materials to build cookers and travelled to Arequipa and Colca Canyon. In Yanque we met Sister Sarah and saw their oven made by Mark and Andy. In Arequipa, Geovana Quezada-Rivera is a shining light of enthusiasm and expertise in solar cooking. She updated our instruction booklet with improvements based on what they've learned in the last 3 years. She led us to meet Sister Patricia and see the solar cooker which they use every day.

Above: Someday little Mali Huatta Yucra will consider cooking with the sun to be “the way it’s done.”

The Arequipa group had made several interesting discoveries. One is that the foil on the reflector panel can be replaced by mylar gift wrapping paper, available in every libreria. It is printed on one side but very brilliant on the other, and can be taped in place. The cardboard panels could be made with folded parts of boxes by gluing reinforcement cardboard on the back of the fold. Lining the outside of the interior box with foil reflects the heat back into the cooking area.

The glass is reinforced with strips of thin plywood glued directly all around the glass, top and bottom, with an extra piece of wood glued to the top of the glass for a handle. Then, around the glass they glue and nail a frame on the face of the box for the glass to sit, with an extra thickness for support on the lower side. This forms an effective seal of wood to wood for the oven opening, protects the glass from breaking, and protects the cook’s hands.

Black Interior or Foil Lined?

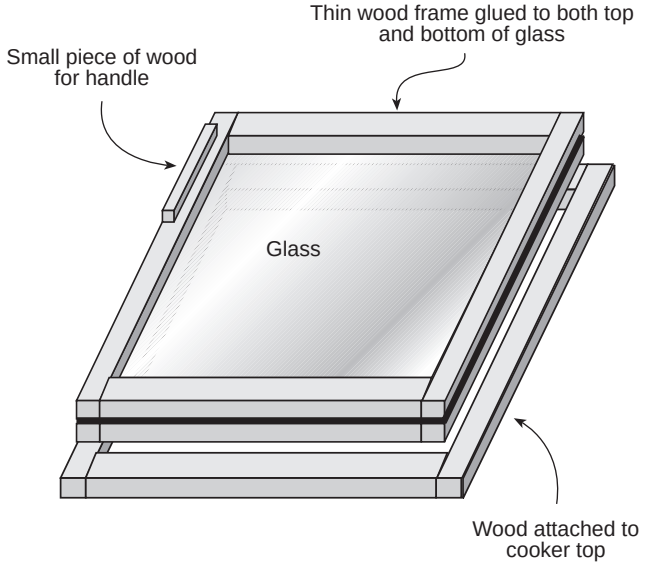
They also recommended lining the interior with foil instead of making it black. Solar oven experts have two schools of thought about the oven’s interior: make it black, or line it with foil. Patricia and Geovana claimed 10˚C (18˚F) temperature increase with foil. We suggest that your decision should be based upon what you are planning to cook. For baking we recommend a black box with some thermal mass. Black rocks on the floor of the oven level the pots and provide mass. That way a small cloud can block the sun for a moment and the cake or bread isn’t ruined. A foil interior requires a black pot, essential to absorb the heat, and may be more efficient since the pot and food get hotter than the oven.

In Arequipa they painted the outside of pots with black latex, we painted the tops of the lids of pots on Taquile with a mixture of black tempera paint and white glue. Either of these water-based paints will need to be maintained since the black wears off over time and use.

Hecho en Taquile

When we returned to Taquile after a 12 day absence, we found that Julio and Esteban had completed 3 working ovens and one more half finished, built from the materials we had purchased. These were small, copied from our sample oven rather than from the booklet, and made with a plywood interior instead of cardboard. One was painted with enamel oil-based paint and still smelled of solvent, but the paint seemed to cure as time went on. We hold hope that it will eventually completely cure in the heat of the oven, although we still recommend the use of non-toxic paint for the cooking box.

Over the next two weeks we enjoyed weddings and festivals and the launching of a newly built boat. We worked for several days in an outdoor carpenter shop, well equipped with hand tools, which generously shared their boat building space for us to construct solar ovens. We demonstrated twice more on the plaza. By that last Sunday, at least four ovens were in various stages of being built, and six ovens had been finished on the island. One was labeled Hecho en Taquile to the amazement of community members. Our favorite was a tiny cooker built on their own by 15 year old Elias Yukra and his 12 year old cousin, Fredy Huatta, from all cardboard and glass and foil scraps. Their reflector panels were made from the cardboard in which their photovoltaic panels had been packed! We had demonstrated boiling water and cooking traditional foods such as soup, potatoes, oca (an Andes edible



tuber), fish, chicken, and rice. For the dramatic finale, I baked yeast bread. All of the ovens held 325˚ F (160˚ C) over several hours.

From the first day we explained that we were not expert carpenters, but expert solar cookers. When people wanted to buy ready-made ovens rather than build them themselves, we told them we thought a local carpenter could make a profitable business building solar cookers. By the time we left at least three skilled carpenters were knowledgeable and interested, and the whole island was full of potential customers.

As we worked with the men constructing the cookers, we continually emphasized that they should design them for easiest use. It wouldn't do any good, we pointed out, for the men to build them if the women didn't use them to cook. The incentive is high, however, since if they only cook one meal per day they can save the materials cost of about $15 in kerosene in a little over two months, and the labor of wood and cow dung gathering is extensive and difficult. The women in the three households within our family were beginning to use the cookers regularly, starting by putting water on to boil early, then using it to make soup or rice.

The Dream is Planted

I told our hostess, Celbia Yukra-Huatta, that I had a vision of a festival in which all of the neighbors brought their solar cookers for a group cooking. The sunny space in front of the house was full of solar cookers. All the women were dancing in the courtyard. They came out occasionally to adjust the ovens toward the sun, returning to dance and enjoy the party. Celbia said, "This is a dream, right?" She's right, for now it is only a dream, but the seeds have been planted in rich soil. Between Pacha Mama and Inti and the community spirit of the people of Taquile Island, solar cooking will grow and thrive on Lake Titicaca.

Access

Author: Tara Miller and her partner Sam Brown earn a living making and selling high-fired, stoneware fine pottery in rural Western Colorado. They plan to return to Taquile soon to follow up on the solar cooking project. Someday they will be on the internet to start a home page about solar cookers and to network with travelers to Taquile.

They can be reached at 4136 Road O, Paonia, CO 81428 • 970-527-6570 • Email: tarasam@aol.com

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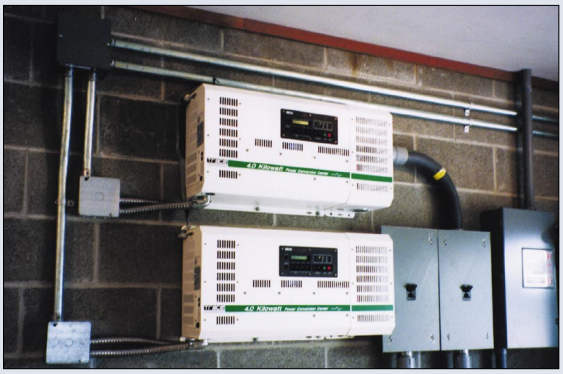

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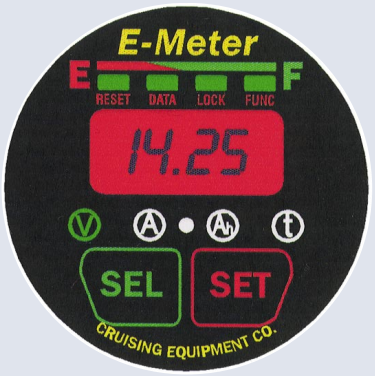

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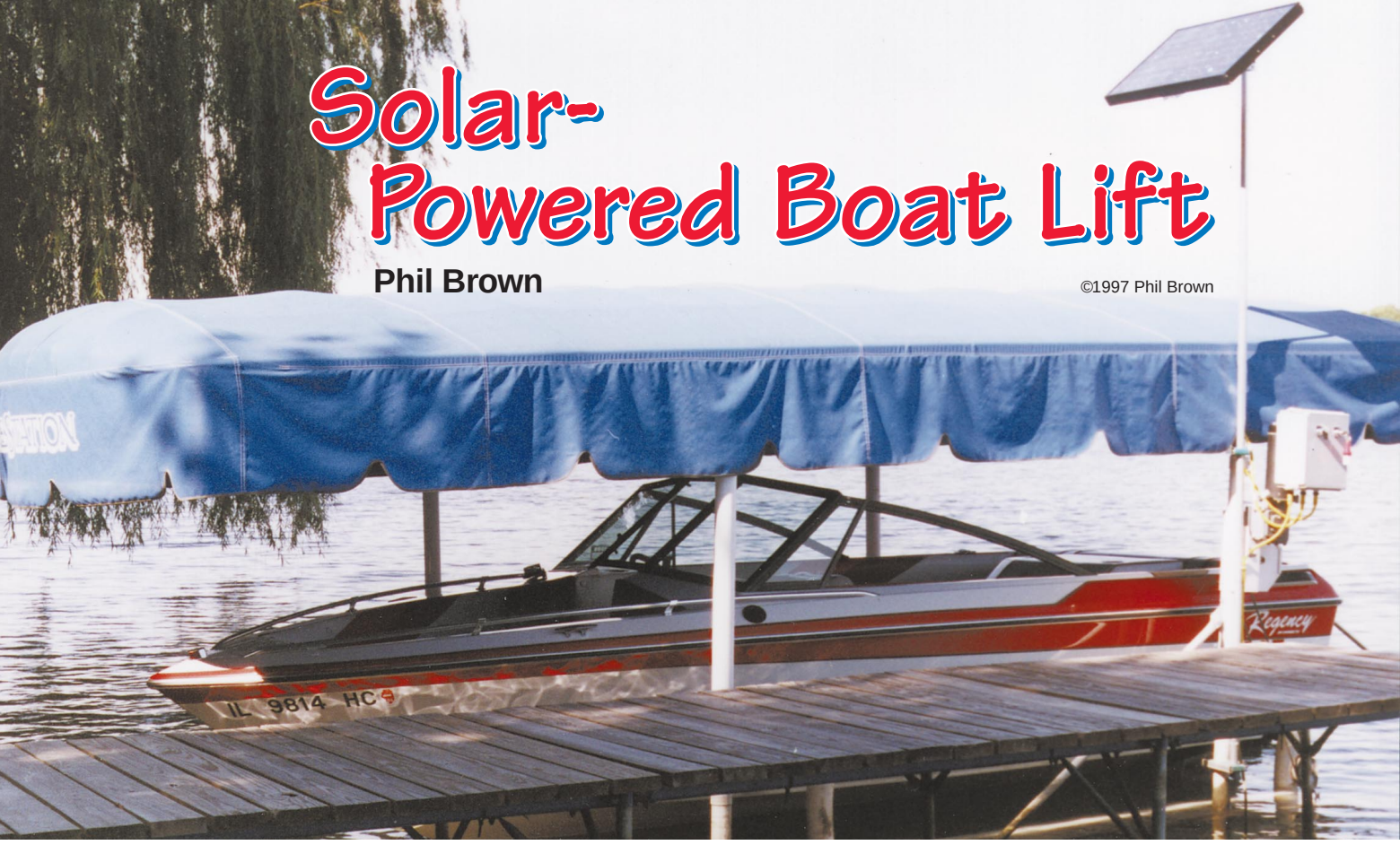
Solar-Powered Boat Lift

Phil Brown



In the Midwest, many boaters store their water craft on lifts. These lifts suspend the boat above the water to keep the hull clean and protect the craft from the weather. If you're wondering what this has to do with alternative energy, read on.

We've Got A Problem

In order to raise the boat out of the water, you need to turn a large winch wheel about 50 to 60 turns. This is a laborious, hand-over-hand task that takes about ten minutes. All this to raise the boat about three feet. There must be a better way.

The lift manufacturer offers a 120 volt ac motor with a friction drive to turn the large wheel. This is an improvement, but you still need grid power. You sometimes also end up with a live extension cord dangling off the end of the dock. Does anyone see a safety problem here? I felt this application would be better served using 12 Volts DC. This would seem to be the perfect spot for a stand-alone PV system.

Getting Started

First, I needed to decide how fast I wanted to raise the boat. 60 seconds is a good starting point. That's 50 turns of the wheel in 60 seconds. A standard motor rpm is 1800. 1800 divided by 40 (40 to 1 is a readily available gear box ratio) equals 45. That's 45 turns in one minute, close enough.

Below: Phil's boat in the "up" position nestled under its protective canvas.

Left: A view of the control box, gear box, and cable lift mechanism near the aft of.Phil's boat.

Right: The Scott one horsepower DC motor behind the control box with gearbox below.

Now we need to find out how much horsepower is required. Using a torque wrench on the nut that attaches the wheel to the winch mechanism, I measured about 600 inch pounds of torque. This is the maximum needed to lift the boat and its cradle, about 3000 pounds. One horsepower at 1800 rpm = 35 inch pounds of torque, 35 inch pounds x 40 (gear box ratio) = 1400 inch pounds less 33% (frictional losses) = 938 inch pounds. Plenty of torque!

A worm gear speed reducer with the correct torque capacity is chosen. The gear box needs to be self-locking, this means the motor can turn the load, not vice-versa. Now we have a way to hold the boat up without a separate mechanical brake. Next the output shaft of the gear box needs to be modified to drive the winch mechanism, removing the large hand wheel. A torque arm is fabricated to keep the gear box from turning around the output shaft.

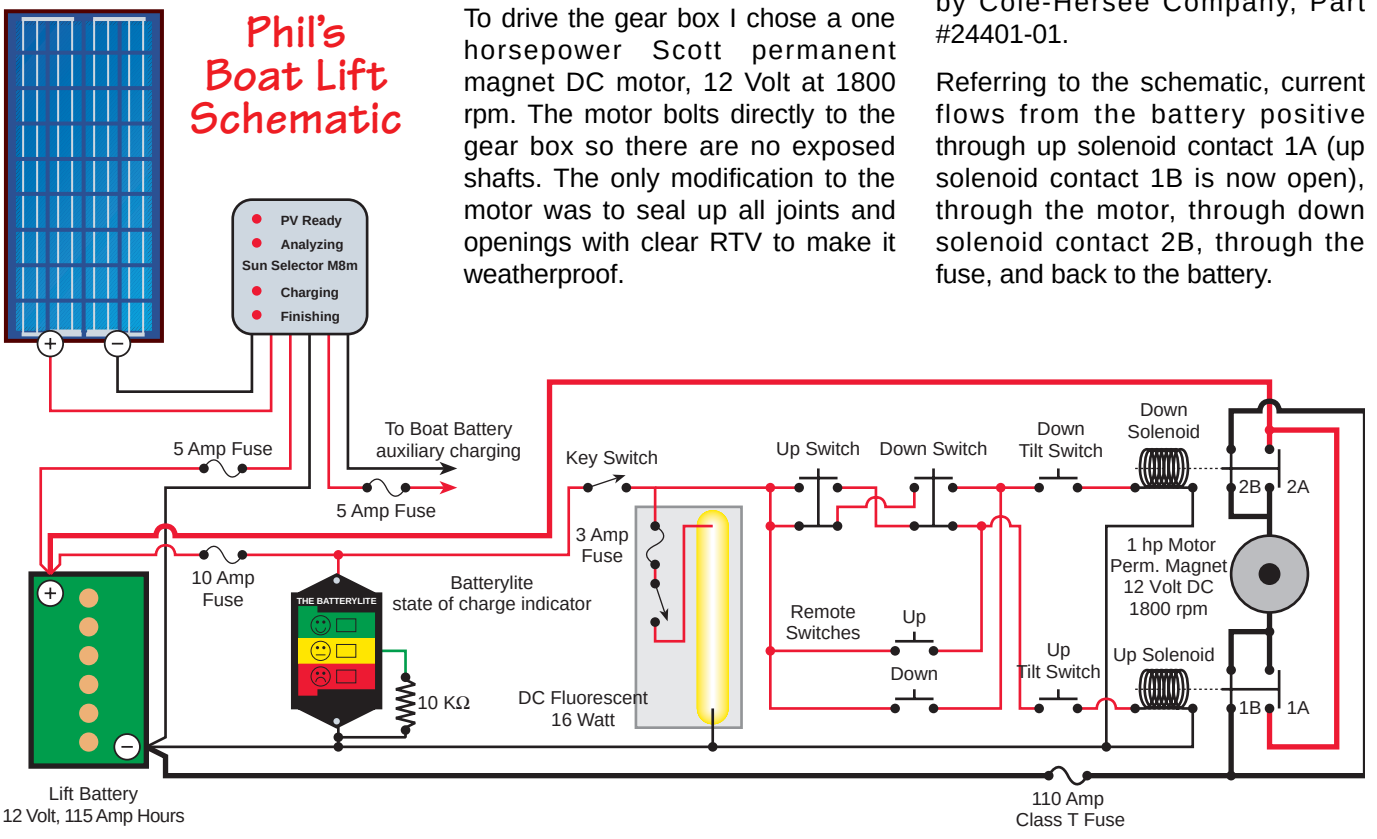
Shafts 'n Gears

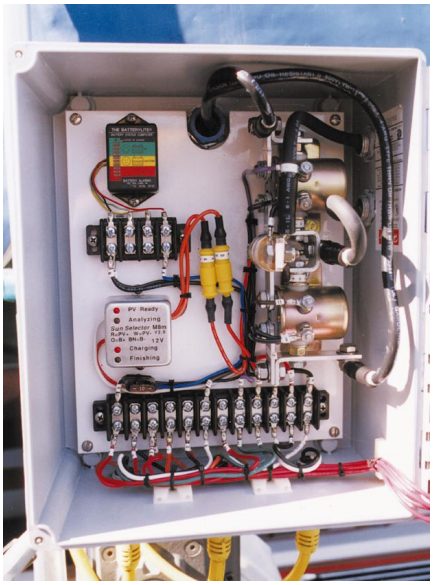
To drive the gear box I chose a one horsepower Scott permanent magnet DC motor, 12 Volt at 1800 rpm. The motor bolts directly to the gear box so there are no exposed shafts. The only modification to the motor was to seal up all joints and openings with clear RTV to make it weatherproof.

Now we need to be able to stop, start, and reverse the motor. This is accomplished with two power solenoids, each with one normally open and one normally closed contact, which are rated for 85 Amps continuous duty. The coils are 12 Volts DC. These solenoids are made by Cole-Hersee Company, Part #24401-01.

Referring to the schematic, current flows from the battery positive through up solenoid contact 1A (up solenoid contact 1B is now open), through the motor, through down solenoid contact 2B, through the fuse, and back to the battery.

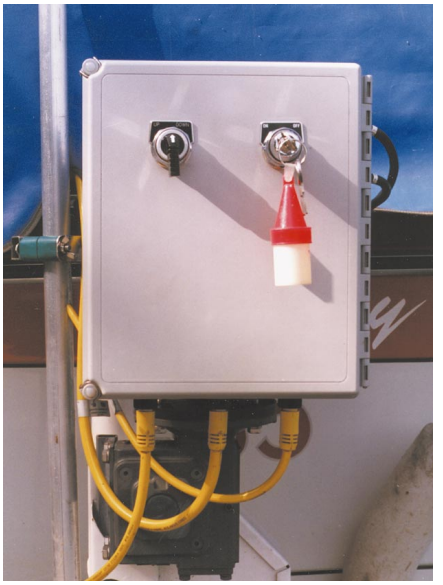
Phil's Boat Lift Schematic





Left: Inside lies the controller, state of charge indicator, fuses, and solenoids.

Right: Outside, the key switch and up / down switch.



We have up, now we need down. Current flows from battery positive through down solenoid contact 2A, through the motor, through up solenoid contact 1B and through the fuse back to the battery. An additional feature of this circuit is dynamic braking when neither solenoid is energized. Up solenoid contact 1B and down solenoid contact 2B shorts the motor to virtually eliminate coasting.

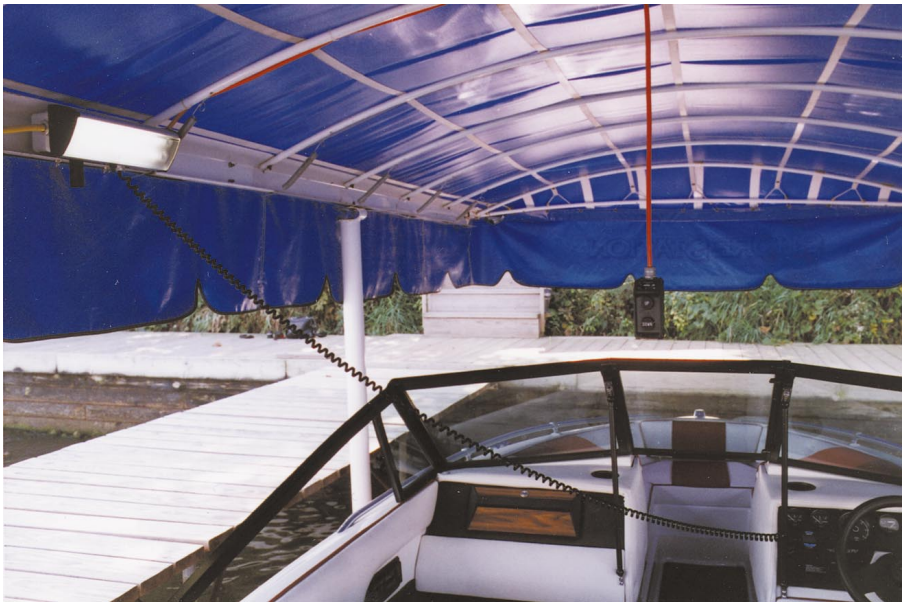
The power wiring at the solenoids is accomplished with 1/8 x 3/4 aluminum strip, easily bent and drilled, available at many hardware stores. This makes wiring neat and compact and minimizes voltage drops. Balance of power wiring is #4 gauge welding cable from the solenoids to the battery. From the solenoids to the motor is #4 gauge THWN copper wire.

The battery is a 12 Volt, 115 Amp-Hour lead acid deep cycle. It is mounted under the canopy roof, close to the motor. To raise the boat the motor draws 60 Amps for about one minute. To lower the boat the motor only draws about 15 Amps for one minute. As you can see, the motor currents are fairly high but running time is very short, so overall energy consumption is low.

The Good Stuff

The battery is charged from a Solarex MSX-40 PV panel. This may seem larger than necessary, but according to my trusty Solar Pathfinder, we have limited solar availability due to the tall trees along the shore and our often cloudy weather. Charge regulation is a Sun Selector M8M. This unit is unique because it has two battery charging outputs. I use the second output to trickle charge the boat battery via a coil cord to the cigarette lighter socket. State of charge indicator is a Photron Batterylite. It gives a lot of battery information and is very compact, but is a little hard to read in bright sun. The enclosure is a fiberglass unit from Hoffman Engineering and is watertight. Switches are Square D industrial units and are also watertight. Other features are 16 Watt DC fluorescent lighting for night time use, and tilt switches to automatically stop the winch at the top and bottom of travel.

Below: The DC fluorescent light, remote up / down controls, and auxiliary charging cord to the boat's battery system.



Below: The lift's battery box with 12 Volt, 115 Amp-hour lead acid battery.

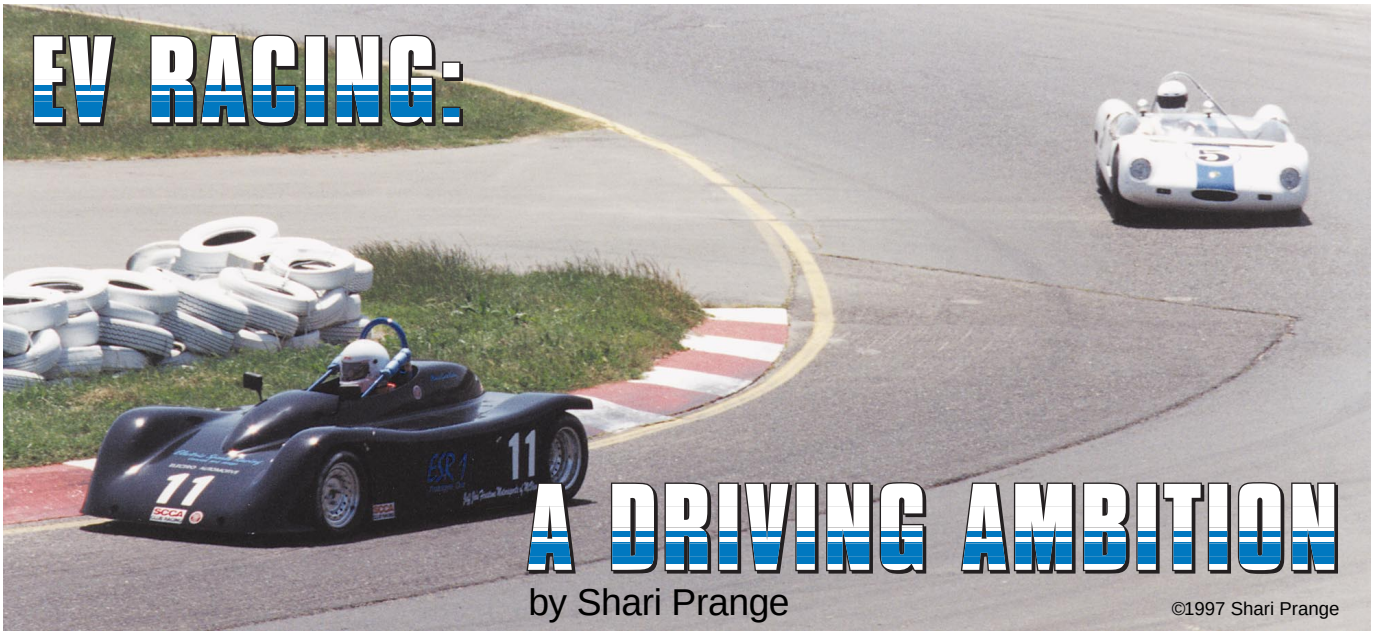
Left: Solarex MSX 40 on tilt-adjustable mounting.

Pullin' with the Sun–Safety First

In conclusion, your homestead may not be located near water, but there are many uses for winches. Much of this information may be useful for winches that are used regularly and not near grid power. When working with winches, you must always observe all ratings on cables, pulleys, gear boxes, etc., so there are no injuries or nasty surprises. Lift safely.

Access

Author: Phil Brown, 828 Holiday Drive, Sandwich, IL 60548 • 815-498-9152.



Above: Different cars will “apex” the same corner differently, depending on their speed and handling.

We’ve been talking about electric car racing: the different kinds of cars and events, the special safety equipment and inspections, and so forth. Now let’s look at actually driving a race car. The general principles are the same for an electric car as for a conventional racer. The specifics vary a little due to the EV’s lower speeds and higher weight.

Rubber Meets The Road

As the cars cruise around the track for a pace lap before the starting flag, you will see them swerving back and forth. They are doing this to warm up the tires by friction.

There are two reasons to want warm tires. First, warm rubber sticks to the track better, so the driver can take curves at higher speeds without losing control. Second, as the tires warm up, the air inside expands, and the tire pressure increases. Tire pressure is set to be optimum when the tires are hot, so the sooner the driver gets them up to racing temperatures, the better.

This can be very critical. On a cold or cloudy day when the track surface is cold, drivers will have to hold back to slower speeds. During a pit stop, even a very brief one, the tires cool down a little, and the driver needs to be cautious until he (or she) gets them warmed up again. In Formula I racing, the pit crews actually wrap electric tire warmers around the tires until just before the race begins, and they keep the spare tires warm in the pits.

Over and Under

On the first couple of laps, the drivers are feeling out the cars, testing the handling. Every race is unique. The car and driver may be the same, but the combination of track configuration, surface condition, speeds, temperatures, and other factors will be different, so the driver has to learn the car a little bit each time out.

The two most common problems are oversteer and understeer. Both of these conditions are caused by a lack of balance in the car. This causes the tires at one end to lose grip before the other end does. If the front tires lose grip, it’s called “understeer”. If the rear tires lose grip, it’s called “oversteer”.

In “understeer”, the driver turns the steering wheel, but the car tries to keep going straight and resists the turn. This is also called “pushing” or “plowing”. To the driver, it feels just like a big hand is pushing out on the nose of the car. The correction is to turn the wheels harder into the curve.

In oversteer, the rear tires break loose in the turn, causing the rear end to whip out and try to pass the front end. This is a classic spin. The car may be described as “loose”. The correction, as we all learned in driver’s education, is to turn the wheels “into the

skid". In a spin to the left, the driver would turn the wheels back to the right until they caught traction again.

Oversteer is the more dangerous condition. It can be harder to correct successfully, and the car can spin in any direction.

A Balancing Act

In electric cars, these problems are usually caused by poor weight distribution and lack of attention to suspension. Most commonly, in stock EV's, the builder makes the mistake of putting all the control components and accessories in one big lump smack in the middle of the engine compartment. He then has no room for batteries in front, so he has to put them all in the rear, making the car tail heavy.

Above: Oversteer can result in a classic spin.

This car rides nose high, which means poor contact under the front tires that do the steering. If the driver tries to turn quickly at speed, the car will defy him and drive into the wall.

Sometimes a car will slide through a turn in what is called a "four-wheel drift", often preceded by the word "beautiful". In this case, the car is perfectly balanced. The driver has pushed it to its limits, and all four wheels have lost grip simultaneously.

It's a skid, but it can be a controlled skid that takes the driver right where he wants to go. (These are expert drivers, kids, don't try this at home.)

Toeing the Line

The path a driver takes around the track is his "line". Some lines are better (faster) than others. Every driver searches for THE line: the fastest, smoothest path around the track and through the turns. As a spectator, you can get an idea where it is from the stains on the pavement. The line will be darker than the rest of the track because that's where most of the cars drive.

Below: The perfect "line" is clearly visible as a dark stripe on the track.

Oval tracks generally have turns that are banked to one degree or another. The line is a combination of the radius of the turn, the degree of banking, and the speed and handling of the car. When the driver finds the perfect line, it almost clicks into place. The various forces acting on the car are all perfectly balanced, and the car drives like it's in a smooth groove.

Of course, sometimes there are other cars in the line ahead of you. That's what makes a race.

Electric cars are heavier than conventional cars, so there is more centrifugal force pulling on them. If balance and suspension are not adjusted properly, the car will handle poorly, and will not be able to take the optimum line.

This was apparent in the early Phoenix races. Some cars took a much higher, wider line through the curves because they didn't handle well enough to stay in the faster line down low. That meant they had to drive faster and farther than the cars on the inside line, just to keep up.

The Apex

The line through the curve is defined by the apex. In simple terms, this is the point at which the driver stops turning into the curve and begins to straighten the front wheels again. It is also usually the point at which he stops braking and begins accelerating out of the turn.

Above: Race car drivers take advantage of aerodynamics by “drafting” within inches of each other’s bumpers.

Apexing at the wrong point can cause the car to exit the corner outside the optimum line—or even outside the track! This can be especially critical on a road course, where the exit from one turn defines the entry into the next one.

The clearest example of this is the slalom. On an autocross course, this is a straight line of cones which the driver must weave through on alternating sides: right, left, right, left. If the driver apexes too late on the first cone, his entry to the second one will be thrown off. The error grows with each cone, the car swinging in wider and wider curves, until by the third or fourth cone it overshoots the turn, or even spins out.

The Draft

Energy conservation is vital to EVs, but it’s also important to conventional race cars. Depending on the type of race, cars may be limited to a certain amount of fuel, or a certain number of pit stops. Even without those limits, if they can keep driving while the other cars pit, the extra seconds could win the race.

One technique to maximize energy is drafting. In drafting, one car follows immediately behind another car for an aerodynamic advantage. When I say “immediately” behind, I mean you can measure the distance in inches.

At racing speeds, this requires courtesy and cooperation between alert, skilled drivers. One wrong move could crash them both. If someone tailgates you on the street, you may tap your brakes to say, “Back off!” However, on the track this is called “doing a brake job”, and it’s considered unprofessional and rude. Both drivers in a draft need to trust each other.

Surprisingly, both cars benefit from the draft. The car in back escapes the resistance of solid air in front of it. The car in front escapes the “negative pressure zone” that forms behind a car and pulls back on it. In effect, the two cars have become one unit moving through the air, and they split the aerodynamic drag between them.

This technique is used with stock cars. It was used a lot in the early EV enduro races at Phoenix. For a long race, a multi-car team might use a draft to extend their fuel range.

Mind Your Manners

Courtesy is an essential part of racing. It is an inherently risky sport. Drivers are pushing themselves and their machines to the limits of their performance, and sometimes those limits are unexpectedly exceeded, with dramatic results. Therefore, it is important that drivers not add to the risk level with carelessness, excessive ego, or rudeness.

Race cars move much faster, and much closer, than normal traffic, so the action appears more aggressive to the spectator. In fact, there is still a difference between executing a racing pass and cutting someone off. Likewise, slower drivers back in the pack are expected to let the fast leaders pass them.

Training Wheels
Although EVs race at speeds up to 100 mph, this is still about half the speed of comparable conventional race cars. This is probably a good thing, because most drivers in EV races do not have the racing experience to handle higher speeds yet. Both drivers and cars will improve as the sport matures.

For those interested in driving in EV races, I would recommend attending a race driving school if at all possible. Although you will practice in a conventional car, you will learn techniques you can transfer to your EV.

Another good place to learn driving is at an autocross sponsored by the Sports Car Club of America (SCCA). An autocross is a temporary course full of all kinds of curves. It is set up in a parking lot, using plastic cones to define the track. Cars compete one at a time against the clock. No special license or equipment is needed other than a helmet.

As long as your EV is reasonably well-built and safe, you will probably be allowed to compete in a class with cars of similar performance. You will get a chance to push your limits and learn techniques in safety—if you spin out, you just knock over some cones.

You will meet lots of friendly people who will want to talk to you about your car, and will be happy to offer you driving tips.

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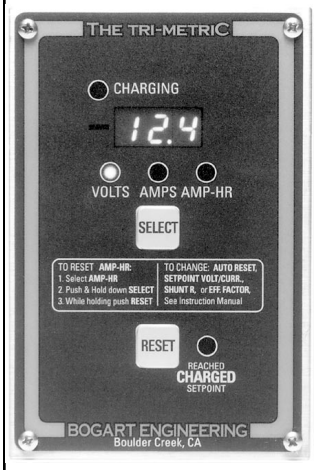

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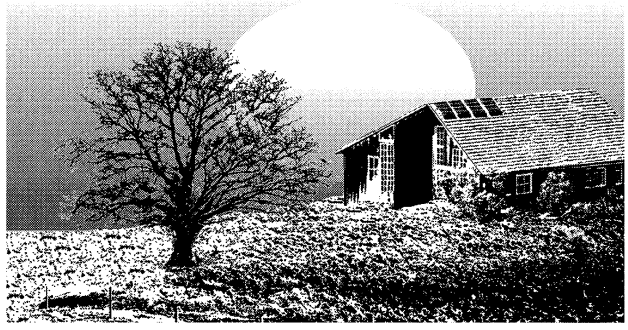

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Harmony with Nature

The Design, Construction, and Use of an

Indirect, Through-Pass, Solar Food Dryer

Dennis Scanlin

Drying is our oldest method of food preservation. For several thousand years people have been preserving dates, figs, apricots, grapes, herbs, potatoes, corn, milk, meat, and fish by drying. Until canning was developed at the end of the 18th century, drying was virtually the only method of food preservation. It is still the most widely used method. Drying is an excellent way to preserve food and solar food dryers are an appropriate food preservation technology for a sustainable world.

Food scientists have found that by reducing the moisture content of food to between 10 and 20%, bacteria, yeast, mold and enzymes are all prevented from spoiling it. The flavor and most of the nutritional value is preserved and concentrated. Vegetables, fruits, meat, fish and herbs can all be dried and can be preserved for several years in many cases. They only have 1/3 to 1/6 the bulk of raw, canned or frozen foods and only weigh about 1/6 that of the fresh food product. They don't require any special storage equipment and are easy to transport.

The solar dryer which will be described in this article is easy to build with locally available tools and materials (for the most part) for about $150 and operates simply by natural convection. It can dry a full load of fruit or vegetables (7–10 lbs) thinly sliced in two sunny to partly sunny days in our humid Appalachian climate or a smaller load in one good sunny day. Obviously the amount of sunshine and humidity will affect performance, with better performance on clear, sunny and less humid days. However, some drying does take place on partly cloudy days and food can be dried in humid climates. The dryer was developed at Appalachian State University in the Department of Technology's Appropriate Technology Program. Over the last 12 years we have designed, built, and tested quite a few dryers and this one has been our best. It was originally developed for the Honduras Solar Education Project, which Appalachian State implemented several years ago. The prototype for that project was constructed by Chuck Smith, a graduate student in the Technology Department. Amy Martin, another Appalachian student, constructed the modified and improved version depicted in this article. Solar dryers are a good way to introduce students to solar thermal energy technology. They have the same basic components as do all low temperature solar thermal energy conversion systems. They can be easily constructed at the school for small sums of money and in a fairly short amount of time, and they work very well. While conceptually a simple technology, solar drying is more complex than one might imagine and much still needs to be learned about it. Perfecting this technology

Above: Yum...the apples are almost ready.

has been one of our goals and while we are not there yet, over the years we have come up with some designs that work pretty well. This article will describe guidelines for designing, constructing and using a solar food dryer.

Factors affecting food drying

There are three major factors affecting food drying: temperature, humidity and air flow. They are interactive. Increasing the vent area by opening vent covers will decrease the temperature and increase the air flow, without having a great effect on the relative humidity of the entering air. In general more air flow is desired in the early stages of drying to remove free water or water around the cells and on the surface. Reducing the vent area by partially closing the vent covers will increase the temperature and decrease the relative humidity of the entering air and the air flow. This would be the preferred set up during the later stages of drying when the bound water needs to be driven out of the cells and to the surface.

Temperature

There is quite a diversity of opinion on the ideal drying temperatures. Food begins cooking at 180˚F so one would want to stay under this temperature. All opinions surveyed fall between 95° and 180˚F, with 110°–140˚F being most common. Recommended temperatures vary depending on the food bring dried. Our experience thus far and the research of quite a few others leads to the conclusion that in general higher temperatures (up to 180˚F) increase the speed of drying. One study found that it took approximately 5 times as long to dry food at 104˚F as it did at 176˚F. Higher temperatures (135°–180˚F) also destroy bacteria, enzymes (158˚F), fungi, eggs and larvae. Food will be pasteurized if it is exposed to 135˚F for 1 hour or 176˚F for 10–15 min. Most bacteria will be destroyed at 165˚F and all will be prevented from growing between 140°–165°. Between 60° and 140˚F bacteria can grow and many will survive, although bacteria, yeasts and molds all require 13% or more moisture content for growth which they won't have in most dried foods.

Some recommended drying temperatures are:

Fruits and Vegetables: (except beans and rice): 100°–130°F (Wolf, 1981); 113°–140° (NTIS, 1982); temperatures over 65°C (149°F) can result in sugar caramelization of many fruit products

Meat: 140°–150° F (Wolf, 1981)

Fish: no higher than 131°F (NTIS, 1982); 140°-150° (Wolf, 1981)

Herbs: 95°–105°F (Wolf, 1981)

Livestock Feed: 75°C (167°F) maximum temperature. (NTIS, 1982)

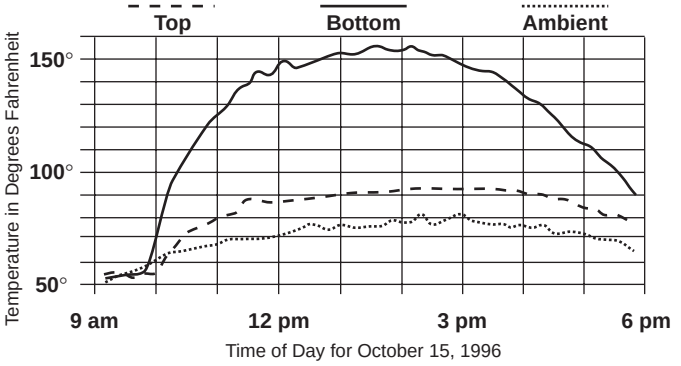
Rice, Grains, Seeds, Brewery Grains: 45°C (113°F) maximum temperature. (NTIS, 1982)

Temperatures Obtainable in our Appalachian Dryer

Our Appalachian dryer, with a reflector added, has reached temperatures over 200˚F on a sunny 75˚F day with all the vents closed. Preliminary experiences with a 4' long reflector have demonstrated a 20˚F rise in the

Below: Adjusting the vents and testing (tasting?) the progress.

Chart 1



dryer temperature and a decrease in drying time. By fully opening the vents the temperature can be brought down to within 10° or 20° higher than the ambient temperature. The dryer can operate for most of the day between 120° and 155˚F by opening the exhaust vents 1–2" (10–20 sq. in.). These are the temperatures at the bottom of the food drying area when the dryer has just been filled with food and a reflector is being used. The temperature drops significantly as it passes through the moist food. Chart 1 shows: the temperatures below the bottom tray of food, the temperatures above the top tray of food, and the ambient temperatures, right after a full load of 25 sliced apples (about 8 lbs) had been placed in the dryer. The dryer on this day had a reflector on it. It was a clear sunny day with relative humidities between 62 and 93%. By the end of the day, apples on bottom 5 trays were dry, some apples on top 5 trays were not. The temperatures were recorded with a Pace Scientific Pocket Logger, model XR220, 1401 McLaughlin Drive, P.O. Box 10069, Charlotte, NC 28212, (704) 5683691

Chart 2 shows a dryer operating in the afternoon of its second day of drying a load of food. One can see how the temperatures increase in the top of the dryer, as the food in the top of the dryer dries. This test was not using a reflector. By the end of this day all apples slices were bone dry, almost like crackers.

Possible temperature related problems

There are a couple of potential problems associated with higher temperatures. One study reported slightly higher vitamin C loss in fruits dried at 167˚F than at 131˚F. Greater vitamin loss has also been reported for the direct style of food dryer which exposes the food directly to the sun's radiation (ASES, 1983). However, there are many other factors that affect vitamin loss and the losses are different for different foods and different vitamins. I need to explore this topic more fully.

Case hardening is another potential problem associated with drying at higher temperatures. If the temperature of air is high and the relative humidity is low, there is the possibility that surface moisture will be removed more rapidly than interior moisture can migrate to the surface. The surface can harden and retard the further loss of moisture. Solar dryers start off at low temperatures and high humidity and thus avoid this problem, I believe. At least I have not observed it.

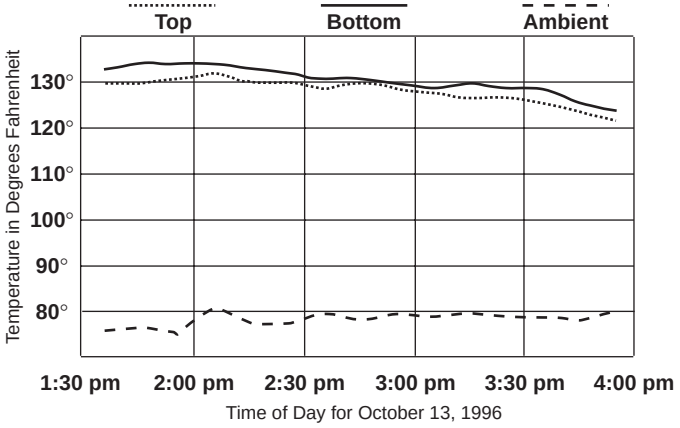
Air flow and velocity

The second of three factors affecting food drying is air flow, which is the product of the air velocity and vent area. The drying rate increases as the velocity and quantity of hot air flowing over the food increases. Natural convection air flow is proportional to vent area, dryer height (from air intake to air exhaust), and temperature. However air flow is also inversely proportional to the temperature in a solar dryer. As the air flow increases by opening an exhaust vent the dryer temperature will decrease. Ideally one would want both high temperatures and air flow. This can be difficult to achieve in a solar dryer.

Air velocity in a natural convection collector is affected by the distance between the air inlet and air exhaust, the temperature inside the dryer and the vent area. The greater the distance, temperature and vent area the greater the velocity. It is often measured in feet per minute (FPM) or meters per second. With constant temperatures, 230 FPM air velocity drys twice as rapidly as still air; at 460 FPM drying occurs three times more rapidly than in still air (Desrosier, 1963). Axtell & Bush (1991) suggest air velocities between 0.5 to 1.5 meters per second which is about 100 to 300 FPM. Desrosier (1963) suggests even higher air velocities between 300 to 1000 FPM.

The quantity of air, measured in cubic feet per minute (CFM) or cubic meters per minute, is the product of velocity and area of the exhaust vent. Morris (1981) recommends 2–4 CFM per square foot of collector for an efficient performing natural convection solar air heater. If the air flows are too slow the collector will heat

Chart 2



up and lose more heat to the air surrounding it. An efficient solar thermal collector should not feel hot to the touch. NTIS (1982) suggests 1/3 to 1/2 cubic meters per minute (11.5 to 17.5 CFM) per cubic meter of dryer volume as being a good flow rate for solar dryers.

Most designers of fossil fuel powered industrial food drying systems recommend considerably higher flows. Axtell & Bush (1991) of the Intermediate Technology Development Group (ITDG) recommend between 0.3 to 0.5 cubic meters per second or about 600 and 1000 CFM. Desrosier (1963) recommends 250 CFM per SF of drying surface. For the dryer described in this article with 18 SF of drying surface that would equal a little over 4,500 CFM.

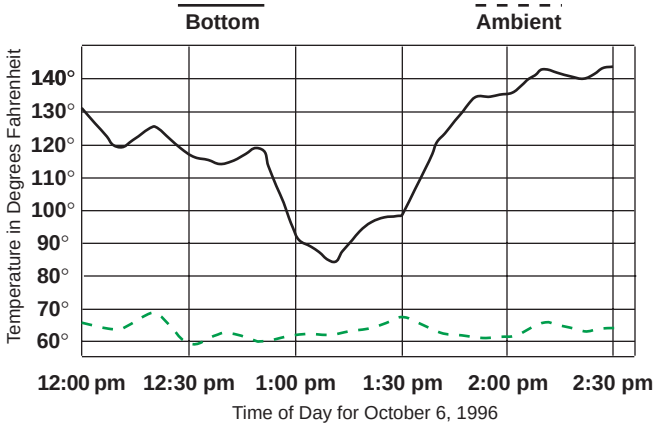
Measured air velocities and flows in the Appalachian dryer

Our solar dryers are only able to achieve air velocities between 50 and 130 FPM with natural convection. Less than most of the 100 to 1000 FPM range recommended. Air velocities were measured in the solar collector's air flow channel with a Kurtz 490 series mini-anemometer.

Our dryer also has less total air flow than is recommended by most. During normal operation it allows 25–60 CFM. A tremendous difference from the 600 to 4500 CFM recommended for industrial drying systems. It has around 9 SF of glazing and should allow, according to Morris, 18 to 36 CFM for efficient collector performance. Our drying volume is about 3 cubic feet (0.08 cubic meters) and would according to NTIS need between 1 to 1.5 CFM. Quite a bit less than recommended by Morris for efficient collector performance and also less than our dryer's normal operating performance.

Increasing air flows and air velocity seems to have potential for increasing the performance of solar dryers. Unfortunately as the air flow increases the temperature decreases in a solar dryer. Chart 3 depicts the temperature decline when the vents are fully opened from a 1 1/2" opening and then almost fully closed. We have found temperature to be more significant than air flow in affecting the speed or rate of drying and so we usually reduce the air flows by partially closing the exhaust vents to increase the temperature. By increasing the power or performance of our solar collector greater air flows will be possible while maintaining high temperatures.

Chart 3



Relative Humidity

While not something one can do much about, the relative humidity is the third factor affecting food drying. The higher the humidity the longer the drying will take. More air will be required and the temperatures will need to be higher. Each 27˚F increase in temperature doubles the moisture holding capacity of the air (Desrosier,1963). In the Appalachian region where we have tested our dryers we normally have a relative humidity throughout the summer and early fall of 55 to 100%. This moist air can't hold as much moisture as less humid air could and as a result drying takes longer than it might in a dryer climate. This humidity also makes higher temperatures desirable for our climate.

How to get the correct temperature and air flow

The temperature obtainable in the dryer will be affected by several things: area of south facing glazing, insulation, air-tightness, area of vent opening, and ambient temperature. The area of south facing glazing is an important design decision. The dryer pictured has 9.2 SF of south facing glazing and approximately 3 CF of drying volume or 3 SF of glazing for every 1 CF of drying chamber. This is a good ratio. If one is interested in drying speed, increasing the ratio of glazing SF per cubic foot of dryer volume, adding more insulation and/or adding a reflector to the dryer would be desirable. This will allow one to increase the temperatures, air velocities and total air flow; and decrease the drying time. The temperature rise in the dryer described can be as high as 125˚F above ambient with a reflector and all vents closed. Normal temperature rises without a reflector and with both exhaust vents opened 1–3" (12–36 square inches) would be 50 to 70˚F. As mentioned previously, our preliminary testing indicates about a 20˚F increase in temperature by adding a reflector. The maximum temperature observed was 204˚F. The higher Delta T's and maximum temperatures will be reached with exhaust vent opening area reduced.

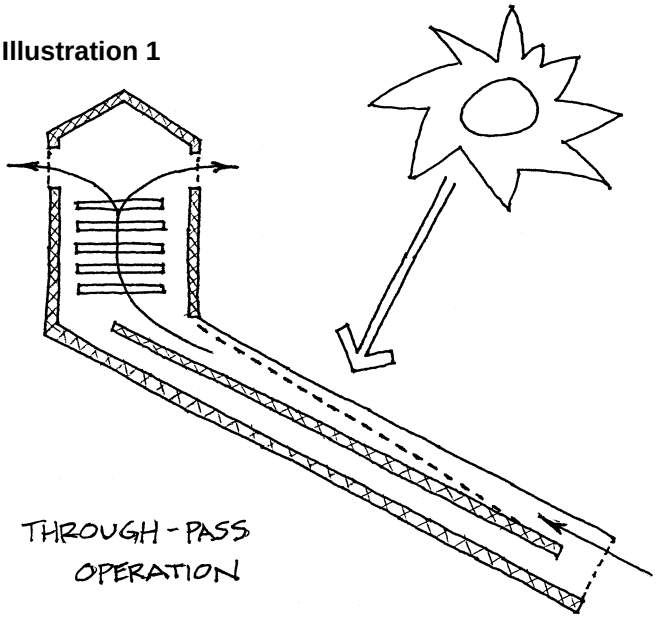
Designing for good air flows involves quite a few considerations. The air flow channel should be properly sized. The depth of the channel should be 1/15 to 1/20th the length of the collector. Making the air flow

path as aerodynamic as possible is also desirable; especially for a natural convection collector. Although turbulence created by fins on the back of an absorber plate or corrugated metal has been shown to deliver as much as 40% more heat in active systems (Morris, 1981). One should try to keep the intake and exhaust vents spread as evenly as possible along the width of the collector to allow easy air movement. The intake and exhaust area and profile should ideally be the same or larger than the air flow channel. Air flow rates can be increased, while keeping temperatures up between 140˚F and 175˚F, by constructing a larger, more efficient, better insulated collector and/or adding a reflector to the collector. Increasing the size and/or performance of the collector can also increase air velocity by increasing the temperature inside the dryer. A larger, more efficient or powerful collector will allow one to more fully open up the vents thus increasing the CFM or volume of air moving through the dryer, while still keeping the temperatures high in the dryer. The dryer described here has 2 exhaust vents with a total of about 1.6 square feet of exhaust vent area. With the vents completely open the maximum temperature attainable on a sunny 70˚F day is only about 85˚F and so we normally decrease the vent area and CFM of air flow to increase the temperature and decrease the drying time. The area of exhaust vent during normal operation for several dryers we have designed and constructed is 10 square inches or less. This enables the dryer to achieve temperatures over 130˚F and still allow air flow. It is desirable to have adjustable vent covers so one can adjust for different foods and weather conditions. Ideally the temperature in a food dryer should be controllable. The air velocity could also be improved by adding a fan, possibly PV powered as has been discussed in a previous HP article, or tall chimneys. Adding chimneys to a dryer and increasing the distance between the air inlet and exhaust will increase the velocity and volume of air moving through the dryer.

Collector design

The dryer uses a “Through Pass” collector configuration. Solar energy passes through a glazing material and is absorbed by 5 layers of black aluminum window screening diagonally positioned in the air flow channel. The air around the absorber, the black screen, is heated and rises into the drying chamber. A slight vacuum or negative pressure is created by the rising air which draws in additional air through the inlet vent and the aluminum mesh absorber. This air is heated and the process continues (Illustration 1).

Illustration 1

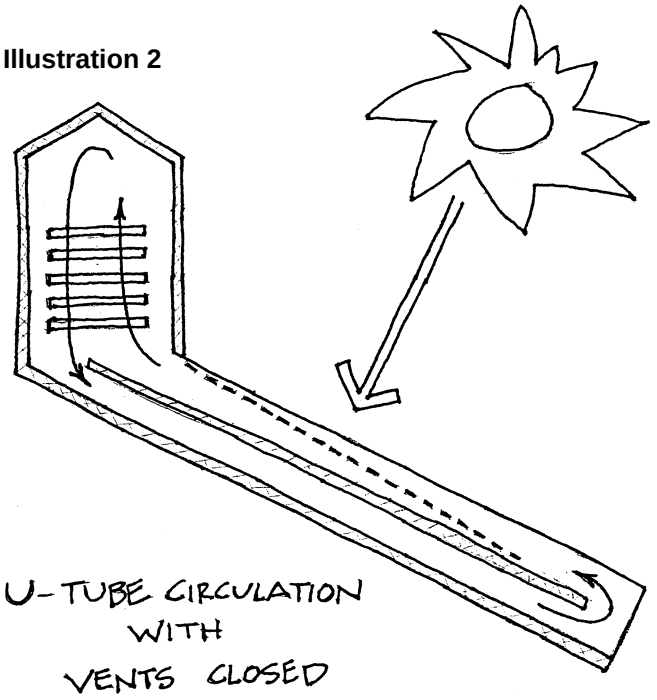


Through pass mesh type absorbers can outperform plate type absorbers by quite a bit if properly designed because the air must pass through the mesh resulting in excellent heat transfer (Morris, 1981). At Appalachian State we have compared the various absorber plate configurations and have found the diagonally positioned mesh type absorbers to produce the highest temperatures inside a box connected to the collector. Expanded wire lathe is recommended by some for the mesh but needs to be painted and didn’t perform any better in our tests than the window screening. Using stock black or dark gray aluminum window screen eliminates having to paint the absorber and is less expensive and time consuming than other options. The bottom of the air flow channel can be painted black or some dark color to absorb any solar energy that gets through the mesh or possibly painted a light or reflective color to reflect sunlight back on to absorber mesh. Morris (1981) recommends a dark color, when we experimented with this we found similar performance with both strategies.

Another characteristic of our collector is it’s U-tube design. In addition to the air flow channel right below the glazing, there is a second air flow channel right below the first one and separated by a 1/2" thick piece of polyisocyanurate foam insulation board. This allows air to circulate when the vents are closed to increase the temperatures for pasteurization or to recycle air that has not absorbed much moisture in the latter stages of drying (Illustration 2).

When the vents are open most air will be drawn up in the top air channel and the bottom channel helps to reduce heat loss to the outside through the bottom of the dryer. The measured air flow velocity in this bottom channel was about 15 FPM with the two exhaust vents

Illustration 2



open 1.5" each and went up to about 25 FPM when all vents were closed. This seems to support the recycling theory. I'm not sure this feature is necessary; but, it doesn't seem to hurt the performance and may be helpful some times. We need to look at this some more.

One significant decision, in addition to size, which needs to be made when designing an air heating solar collector is what depth should the air flow channel be. The air flow channel depth for a through pass collector should be 1/20 the length of the collector (Morris, 1981). The collector pictured is 60" long and has a 3" air deep air space (1/20 x 60") in both air flow channels.

Any kind of glazing will work for this design. Appalachian's dryer has two layers of glazing; the outer is Sun-Lite HP, a fiberglass reinforced polyester (FRP), often referred to as Kalwall. It is available from Solar Components Corporation for about $2.00/SF (121 Valley Street, Manchester, NH,03103-6211, (603) 668-8186). The inner glazing is Teflon manufactured by the DuPont Company, (Barley Mill Plaza 30-2166, P.O. Box 80030, Wilmington, DE 19880-0030, (302) 892-7835). There is a 3/4" air space between the two layers and the glazings are caulked in place. The dryer should face due south for best stationary performance. The altitude angle of the glazing above horizontal should be the compliment of the average noon altitude angle of the sun at your latitude for the months you expect to be using the dryer or your latitude minus 10˚, if you primarily intend to use it during the later part of the summer and early part of fall. For our latitude here in Boone, NC of 36˚ that would be 26˚. The dryer pictured has an angle of 36˚.

The sides and bottom of the collector and the sides, door and top of the drying chamber are insulated with 1/2" Celotex Tuff-R polyisocyanurate foam insulation. It normally is covered with an aluminum foil. I am going to use 3/4" in the next one constructed. Making sure you tightly construct the collector by making good tight fitting joints, especially the door, and using caulks and/or gasket material is also desirable. And finally adding a reflector to the dryer and properly positioning it (about 20˚ above horizontal in early October to 40˚ in mid July at 36˚ N LAT) will improve the performance.

Materials Needed (approximate cost is $150, excluding stainless steel shelf screen)

One 4' x 8' 3/4" CDX exterior plywood for sides, vent covers and door

One 4' x 8' 1/4" exterior plywood for bottom, roof and south wall of drying box

approx. 12 - 8' long 1x2 pine

Two 8' long PT 2x4 for dryer legs

Water resistant glue

Caulk or glazing tape

Eight 1/4" X 2 1/4" lag bolts and washers

24" wide by 30' long piece of black or dark gray aluminum window screen (.65/FT)

Ten 21" x 14.5" Stainless steel screen for drying shelves ($6.62/SF) adds another $150 to cost or could use a vinyl or vinyl clad fiberglass screen for about .35/SF

24" X 12 ft. 0.040 Sun Lite HP plastic glazing ($1.85/SF)

Two 3 1/4" strap hinges approx.

Fifty 1 1/2" galvanized deck screws

paint

Two 2" hook and eyes

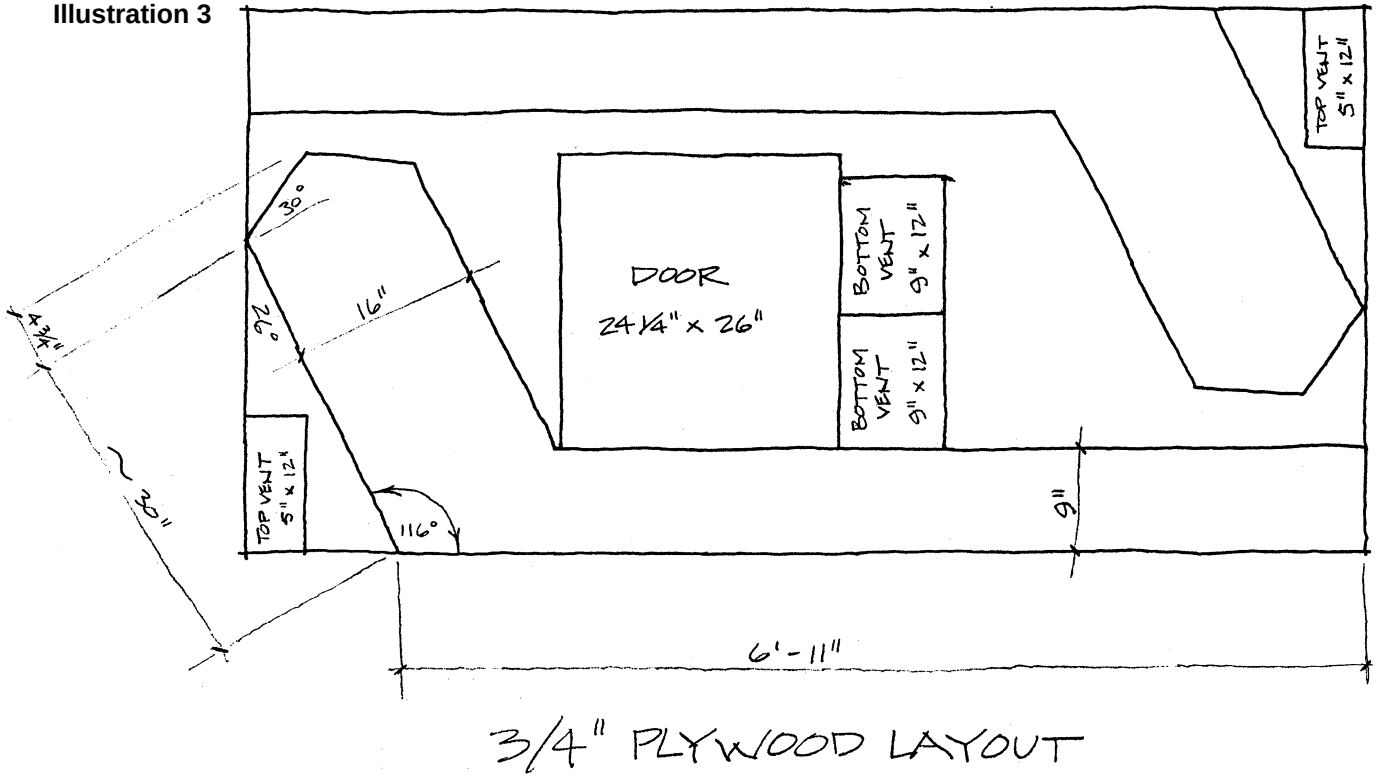
One 4' x 8' 3/4" celotex foil faced polyisocyanurate insulation board

Dryer Construction and Details

The dryer is primarily constructed of 3/4" exterior plywood, 1/4" exterior plywood, 3/4" celotex insulation board, dark aluminum screening, glazing, some 3/4" thick pine boards, and wood screws. The cutout illustrations (Illustration 3 & 4) dimension the layout of the important plywood and insulation pieces.

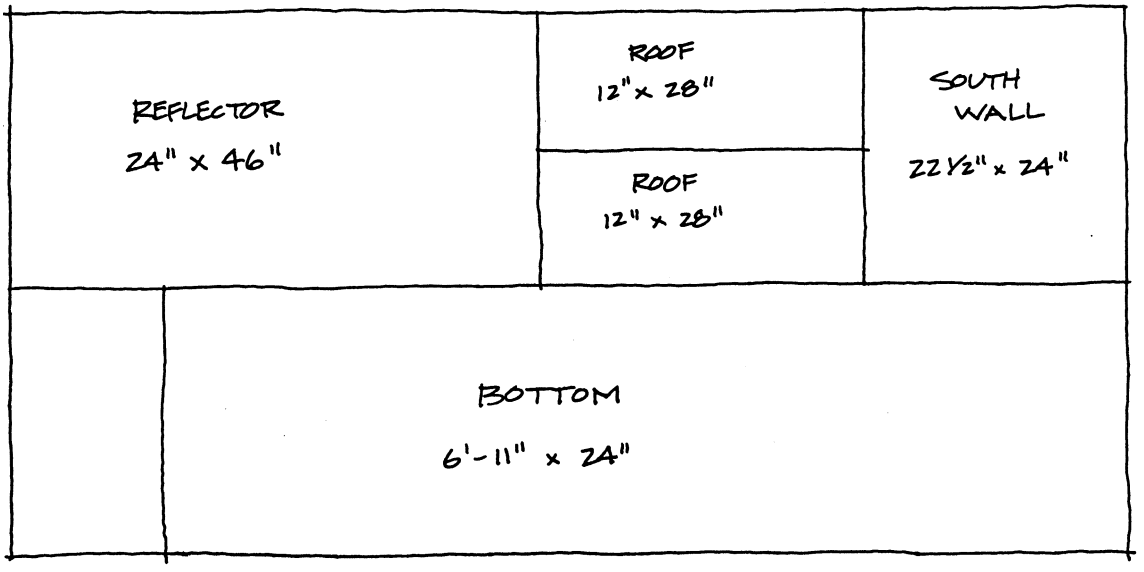
I tried to improve on the design depicted in this article by slightly increasing the glazed area (from about 9 to 10 SF), the SF/CF ratio (from 3 to 3.5 SF/CF), the thickness of insulation used (1/2" to 3/4") and lowering the collector altitude angle (from 36˚ to 26˚) to improve late summer and early fall performance. I am also going to develop a larger and more permanent adjustable reflector. Verify the measurements before blindly cutting

Illustration 3



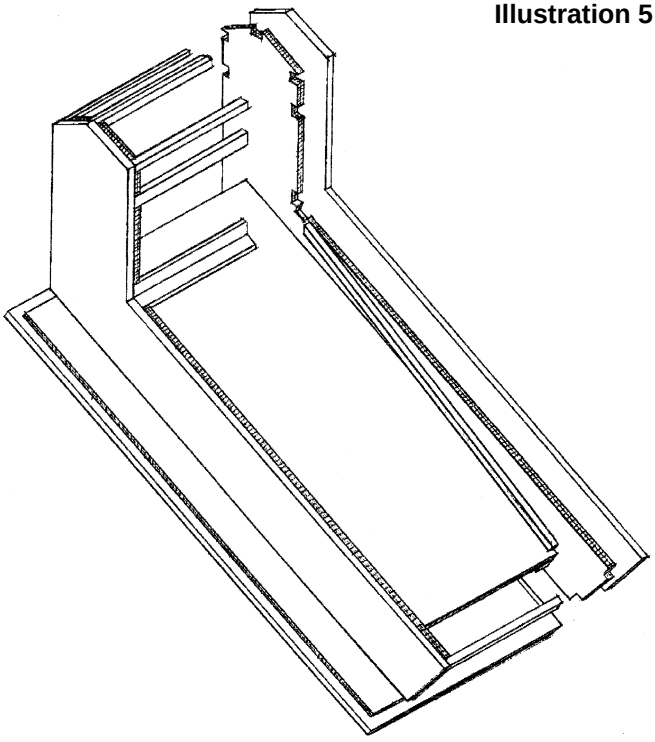
3/4" PLYWOOD LAYOUT

Illustration 4



1/4" PLYWOOD LAYOUT

Illustration 5



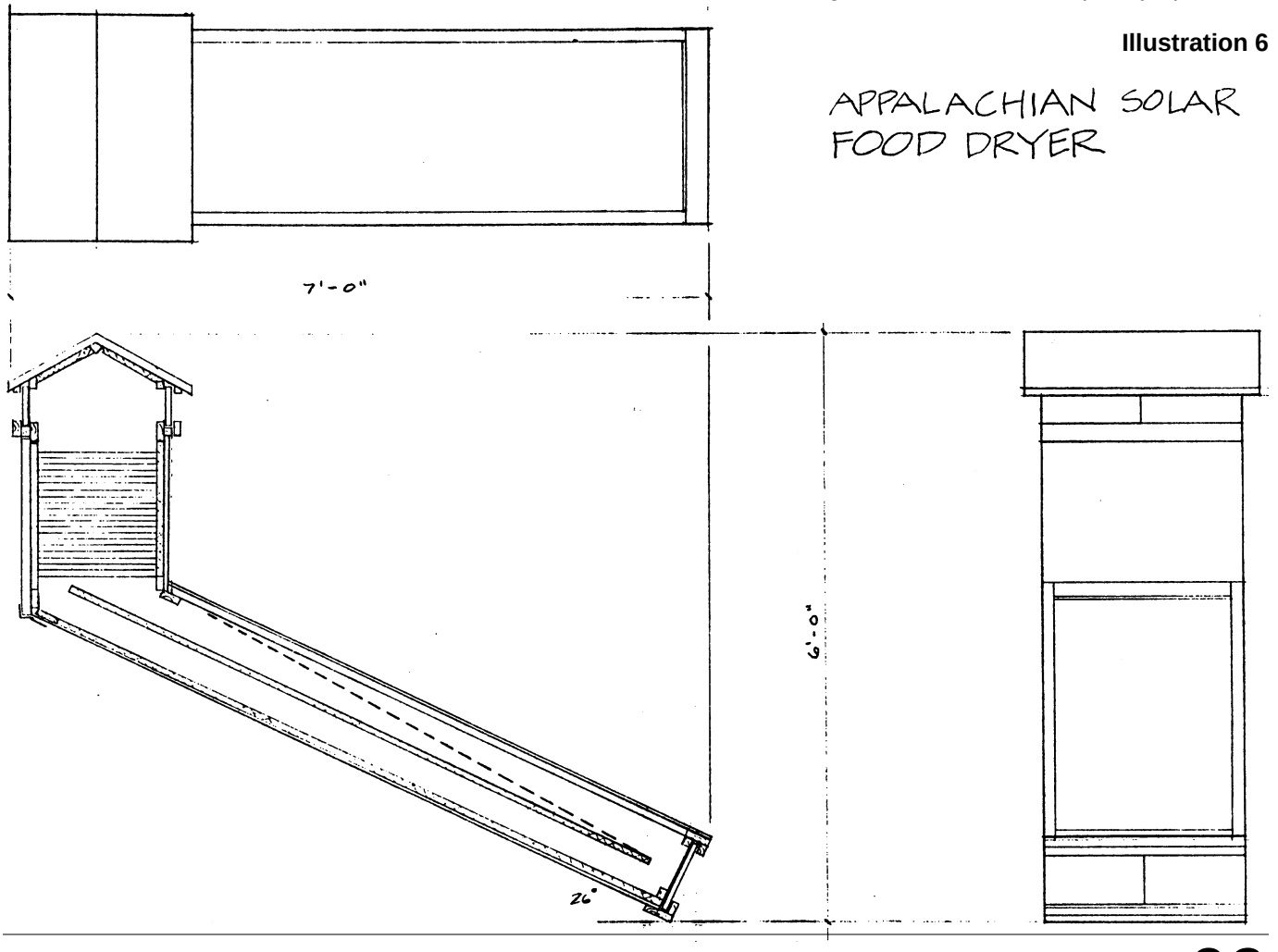
everything out. I tried to be as accurate as I could; however, there may be some mistakes. The exploded isometric drawing (Illustration 5) and the multiview (Illustration 6) illustrate the basic construction.

Basically begin by laying out the dryer sides, the door and the vent pieces on the 3/4" plywood. Cut these out with a skill or jig saw. Cut the 1/4" plywood bottom out with skill saw. Use the plywood side pieces to layout the insulation board dryer side pieces and cut with a razor knife. Glue the insulation to the plywood sides and then connect the sides together by gluing and screwing or nailing the plywood bottom on and screwing the 22 1/2" long wooden struts made from 1x2 stock in place. Illustration 7 describes the location of the most critical struts. Cut out insulation where the struts join the side pieces. Once the basic form is constructed everything else is applied as depicted in plans and photos.

Using the dryer

1) The initial phase of drying is more dependent on air flow than temperature, so keep the bottom vents completely open and the top about 1/2 open or more. After 1 to 2 hours reduce the top exhaust vent opening to 1"–3", leaving the bottom vents completely open, and

Illustration 6



let the temperature rise. Keep the dryer under 180˚ F. Close all the vents at night to prevent rehydration of any food left in dryer. On cloudy days keep the bottom vents closed and the top vents almost closed to keep temperatures as high as possible.

2) Keep everything as clean as possible; wash food gently in cold water 3) Get fruit and/or vegetables in dryer as quickly as possible after harvesting to preserve vitamins

3) Remove blemished and woody areas of fruits and vegetables

4) Consider blanching most vegetables, by exposing to steam for a few minutes and then dipping in ice water, to inactivate enzymes which can cause color, flavor and nutritional deterioration. Blanching helps preserve carotene, thiamine, and ascorbic acid. Blanching also makes cell membranes more permeable, which promotes more rapid drying and will kill potentially harmful micro-organisms. The blanched dried product will often have a softer texture when rehydrated. Blanching apricots, peaches and pears imparts a translucent appearance to the dehydrated product and can also be used for fruits which will not have detrimental color changes during drying: grapes, figs, plums and prunes. Don't blanch onion, garlic, mushrooms, horseradish, herbs, or vegetables with cabbage like flavors

5) Consider sulfuring fruits. Sulfuring helps preserve the light color of apples and apricots and also helps preserve ascorbic acid (C), and beta-carotene (A), and helps control microbiological and insect activity. It also protects delicate flavors and increases the shelf life of dried foods. Sulfuring involves burning elemental sulfur and exposing the fruit to the fumes for 1-5 hrs or dipping the fruit for 30 seconds in a 5–7% potassium metabisulfate solution. When fruit has been adequately sulfured the surface will be lustrous. Pretreating tomatoes with potassium metabisulfate prior to drying has been reported to significantly improve the taste and aroma of sauce made from the dried tomatoes. Sulfur flowers are available at pharmacies or use pure sulfur from garden centers. Use 1 tbls/lb of fruit. Thiamine is destroyed by sulfuring.

6) Slice food thin (1/8") for most rapid drying and cut uniformly.

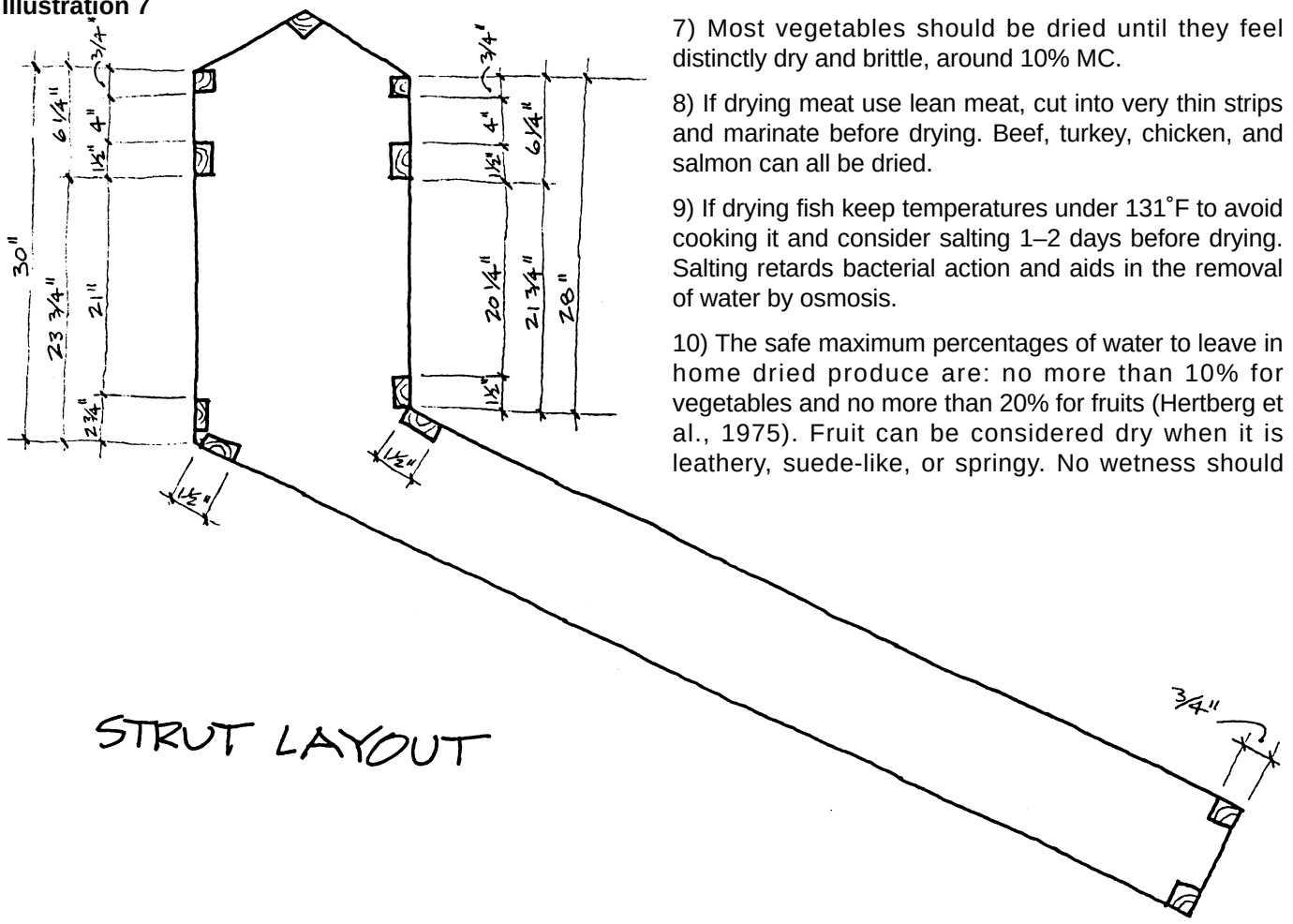
7) Most vegetables should be dried until they feel distinctly dry and brittle, around 10% MC.

8) If drying meat use lean meat, cut into very thin strips and marinate before drying. Beef, turkey, chicken, and salmon can all be dried.

9) If drying fish keep temperatures under 131˚F to avoid cooking it and consider salting 1–2 days before drying. Salting retards bacterial action and aids in the removal of water by osmosis.

10) The safe maximum percentages of water to leave in home dried produce are: no more than 10% for vegetables and no more than 20% for fruits (Hertberg et al., 1975). Fruit can be considered dry when it is leathery, suede-like, or springy. No wetness should

Illustration 7



come out of a cut piece when squeezed. A few pieces squeezed together should fall apart and spring back when pressure is released. Vegetables should be brittle, or tough to brittle almost crisp like crackers or potato chips.

11) Put screen over the intake and exhaust vents to keep insects out.

Tips for Storing Dried Foods

1) Cool food to room temperature before packaging

2) Store dry fruits and vegetables in small, airtight, moisture, insect and rodent proof containers in dark, cool, dry and clean places. Glass jars, plastic bags, or plastic containers that can be sealed tightly are good. Store grains, roots, and legumes in places with good air circulation (NTIS, 1982).

2) Dried meats and fish should be stored below 5°C (41°F) to avoid rancidity (NTIS. 1982).

3) Most fruits and vegetables will keep for 6 months if stored at 70°F and 3-4 times that long at 52°F (Wolf, 1981).

4) Meat and Fish can be stored dried for several months in moisture proof, airtight containers. (Wolf, 1981)

5) If drying herbs store in uncapped jars for 24 hrs, if moisture collects, herbs need additional drying

6) Refrigeration or freezing will extend life of dried food.

7) Carefully label the food.

Influence of dehydration on nutritional value of food

While all methods of food preservation result in a degradation of the food quality and drying is no exception, drying food does increase the concentrations of proteins, fats and carbohydrates. Fresh peas are 7% protein and 17% carbohydrates; dried peas 25% protein and 65% carbohydrates. Fresh beef is 20% protein and dried is 55%. There is; however, a loss of vitamins. The extent of vitamin loss will be dependent upon the caution exercised during the preparation of the food for drying, the drying process selected, and storage of dried food. In general indirect drying methods such as the dryer described in this article retain more vitamins than sun drying or direct drying and also better than canning. Ascorbic acid, and carotene can be damaged by oxidative processes. Thiamin is heat sensitive and destroyed by sulfuring. The carotene content of vegetables is decreased by as much as 80% if dried without enzyme inactivation by blanching or sulfuring. Thiamin will be reduced by 15% in blanched vegetables and up to 75% in unblanched. In general more rapid drying will retain more ascorbic acid than slow drying. Usually dried meat has slightly fewer vitamins than fresh. Fruits and vegetables are generally rich sources of carbohydrates and drying, especially direct sun drying, can deteriorate carbohydrates. The addition if sulfur dioxide is a means of controlling this deterioration.

Influence of drying on Micro-organisms

Living organisms require moisture; so by reducing the moisture we are able to reduce the ability of molds, bacteria, and yeasts from growing. Bacteria and yeasts generally require moisture contents over 30%. Drying food lower than 30% is no problem in a solar dryer. Molds however can grow with as little as 12%. Molds also require air, so as long as dried food is stored in an airtight container molds should not be a problem. Also if food was dried at over 140°F or if it was pasteurized prior to and after drying all 4 of the problem causing agents will be destroyed. Salt can be also used to control microbial activity if drying fish or meat. It is also important to start with clean food and utensils, and store food away from dust, rodents, insects and humidity.

Influence of drying on Enzyme activity

Enzymes are produced when plant tissues are damaged. Their production can lead to discoloration, loss of vitamins, and breakdown of tissues. Most enzymes are inactivated at 158˚F. They also require moisture to be active and their activity decreases with decreasing moisture. But dried food still has some moisture so food deterioration due to enzymes can still be a problem. Browning of fruit for example and loss of carbohydrate content. One minute of moist heat at 212 F will inactivate enzymes. This can be achieved by blanching. Sulfuring also deactivates enzymes. Surprisingly dry heat does not affect enzymes very much. Short exposures to a dry 400°F has little effect. Blanching times vary. In general 1–3 minutes for leafy vegetables, 2–8 for peas, beans, and corn and 3–6 for potatoes, carrots, and similar vegetables.

Access

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Things That Work!

Things that Work!
tested by *Home Power*

Jade Mountain's **Solar-powered LED Light**

Richard Perez

Here is a complete solar electric lighting system for under $100. The light is a super efficient, white LED lamp that will last for over 20 years. The system comes complete with photovoltaic (PV) module, battery, low voltage disconnect, wiring, and all connectors. It works well and has been providing light for us every night for the last four months.

It's a System!
I have reviewed several LED lamps in the past. This unit, made by Jade Mountain, is different. It is it is not only a super-efficient LED light, but also a complete solar electric system. The energy is sourced by a small PV module and stored in a battery. The energy can then be used at night to power a white LED light which is bright enough to read by.

The PV Module
The module supplied with this system is housed in a 7 inch wide by 9 inch long plastic container. The module comes with an adjustable mounting flange and is ready to screw to a wall, or roof, or whatever. I mounted ours to a South facing wall on our main building. The module is equipped with a ten foot cord with polarized connector. Installation is super-simple because of the attached mounting flange. The unit is also easily tilt adjustable for seasonal changes.

Above: Jade Mountain's, super-efficient, light uses twelve Light Emitting Diodes (three blue and six red) to provide "white" light that's bright enough to read by. Power consumption is less than one Watt!

The Battery
The battery is made by Power Sonic and is a sealed lead-acid, gel cell type with a capacity of 4.5 Ampere-hours at 12 Volts DC. It measures 3.5 inches wide, 4 inches high, and 2.75 inches deep. It weighs about three pounds.

The Low Voltage Disconnect (LVD)
One of the nifty features of this LED lighting system is the low voltage disconnect which prevents ruining the battery from over discharge. The circuit is micro-miniature and fits into the regular ole' light socket where the LED light connects to the battery. We left the light on during an extended cloudy period, and the LVD shut the system down when we had depleted the battery. It works!

Plugs, Wires & Socket
This system comes with all the wire and connectors needed. The wire is of jumbo size considering the low currents involved. The connectors are robust and, more importantly, polarized—it impossible to connect anything wrong.

Above: This small PV module, supplied with the system, makes more than enough solar electricity to run the LED light for about six hours nightly.

The socket is a standard 120 vac lightbulb socket with a switch built-in. The LED lamp simply screws into the socket just like a regular ole' lightbulb. The socket comes with a ten foot cord and polarized connector. Everything about this system is plug-and-play simple. The only tool I used to install the entire system was a screw driver to attach the PV to an outside wood wall.

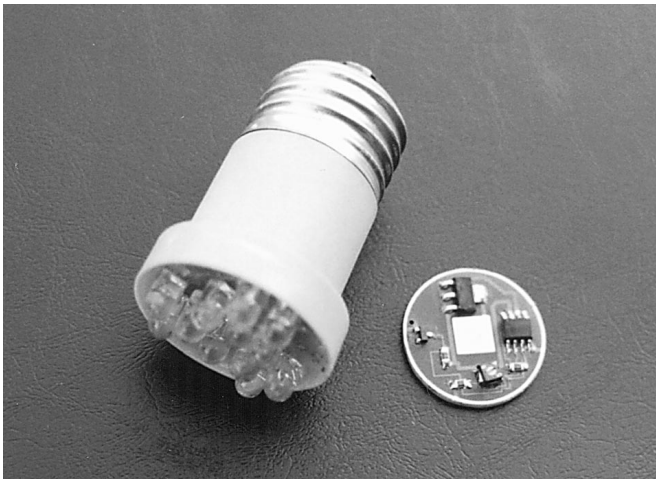
The LED Light

The 1.3 inch diameter light contains three blue LEDs and nine red LEDs. When it comes to making light from electricity, there is no more efficient technology than the Light Emitting Diode (LED). This light, which is a collection of 12 LEDs, only consumes 0.072 Amperes of current at 12.86 Volts DC. This is 0.93 Watts.

System Performance

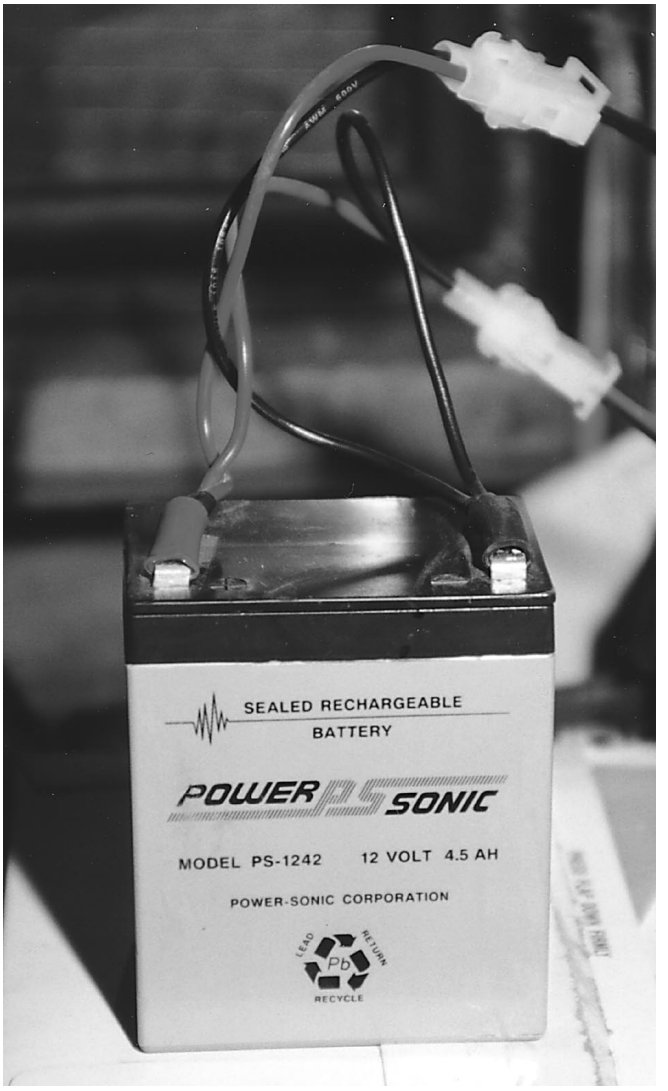
At a distance of between 1.5 to 2 feet, these LEDs produce enough light to easily read by. At a distance of six feet, I can easily see objects on a circle of the floor about four feet in diameter. At night, this lamp produces more than enough light to allow navigation (e.g. I can walk around without bumping into furniture or stepping on one of our many cats' tails) through a 10 by 12 foot room.

The lamp provides a very good imitation of white light by mixing the colors made by the blue and red LEDs. While not color correct by any standard, the light allowed me read a copy of Home Power and be able to



Above: The LED Lamp, which can be bought seperately, and the Low Voltage Disconnect (LVD).

Below: The battery and fool-proof, easy-to-use, polarized connectors.



distinguish the colors in the photos and art. More importantly, the paper appeared to be white. While not color perfect, this LED lamp makes light that is white enough to be acceptable for reading and working.

We have been turning on this light almost every night for between five to eight hours. The supplied solar system has had no problem keeping this light going. The only time it has refused us light was during the deliberate, low voltage disconnect test when we left the light on all the time. If you put the PV module in a good solar location, then expect this system to provide at least six hours of light per night.

Conclusions

This is a great, first electric light for most of the developing world. It's simple, complete, durable, inexpensive, and sustainable. This lighting system makes a great solar-starter for folks who are grid connected. It's a complete system—energy source, energy storage, and appliance—a great way to get into solar electricity. It's a great lighting system for nomads or campers—light and small enough to fit into a back pack!

The entire system, that's PV, battery, LVD, all wiring/connectors, and the white LED light costs only $96. And that's the cheapest entire PV system I've ever heard of. For those who wish to use the LED light on their existing 12 VDC system, the lamp is available alone for $48. Considering the utility and function packed into this small package, Jade Mountain deserves a big Thumbs Up!

Access

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Still Waiting

Don Loweburg

Last issue we detailed Dave's story as he attempted to get net metering established with Pacific Gas and Electric. Since the utility was and is not cooperative, he has filed a protest with the California PUC and to date there has been no outcome. His story prompted several contacts both within California and out of state who are involved in projects that want net metering. IPP will continue to help provide information and provide contact information on a regional basis. From all our experiences, most utilities are dragging their feet when it comes to any kind of customer self generation. Although people are using state of the art inverters that meet safety standards, the utilities continue to use outdated safety issues as the primary blocking tool. The real issue is perceived competition. Even though customer self generation amounts to a raindrop in a river at this point, most utilities are seen as foolishly fighting it tooth and nail already.

A Better Idea?

Brian, an IPP member from Ohio, tells a story that serves well to illustrate this general utility mindset and attitude. Through efficiency measures and PV self-generation, he had reduced his monthly electric bill to $18. He called his local service office and asked if there might be another rate that would reduce his bill further. The service person flatly could not understand Brian's request, thought he must be complaining about a faulty meter, and had a lineman visit and swap meters! Experiences like Brians and many more reported to IPP are leading some people to the conclusion that the best thing to do is tell the utility nothing. This is a completely understandable, although potentially dangerous situation. Utilities, be aware that this unwelcome situation is of your making!

IPP, in conjunction with other industry members, has proposed the Simplified Net Metering Interconnection Agreement as a utility model. Adoption of this standard would encourage customer compliance and help the utilities maintain a safe distribution network. Thank you to Southern California Edison who has adopted this standard and, in fact, helped write it as an active member of the California PV Collaborative.

Restructuring and Renewables in California

Last issue it was mentioned that the California utility restructuring process had been moved to the legislature with the passage of AB 1890. As part of that legislation, about $500 million was earmarked for renewables. Of the $500 million, about $100 million could be allocated to PV. The California PV collaborative has put together a consensus proposal endorsed by CAL PV4U, IPP, CAL SEIA, SEIA and SMUD. From the introduction, "It is therefore proposed that a 'California Solar Fund' be created to manage and implement a portfolio of market-based incentives and financing mechanisms designed specifically for grid-connected PV, emphasizing distributed customer-sited applications." The proposal has three elements.

Greenback Program

- Consumer rebates to lower PV system prices to the expected sustainable market level of $3/Watt ac.
- Rebate incentives will be issued over a six year period and decrease each year, starting at $3/Watt ac and declining to $0.50/Watt ac.

Low Cost Loan Program

- Low interest (<5%), long term loans (15-20 years) to finance PV systems in concert with the greenback program.
- Loans could be packaged and sold to the secondary market to create a revolving and growing loan fund.

Quality Assurance & Green Marketing

- A consumer protection program to ensure quality components, licensed contractors, & realistic ratings.
- A professional statewide consumer education and advertising campaign to jump-start the market & augment industry efforts.

The full proposal is available on the Internet at http://www.energy.ca.gov/restructuring/AB1890_renewables/

Special thanks to Howard Wenger of Pacific Energy. He is a major contributor to the proposal. Howard can be reached at HWenger@aol.com. Like the highly successful European and Japanese programs, this proposal gives incentives for end user ownership and hopefully receives wide support.

Utilities and Distributed Generation

Last November the Electric Power Research Institute (EPRI) conducted its second Annual Conference on Distributed Resources in Vancouver, BC. Selected comments made by utility executives at that conference chart the utilities intentions.

The keynote address was given by Peter Schwartz, Chairman of Global Business Network, an affiliate of B.C. Hydro. He discussed the "network effect" that utilities enjoy with respect to their customers. He states that utilities would be foolish to not cash in on these unique advantages, particularly as electricity markets become more competitive. He urged utilities to be proactive in using distributed generation to help shape the outcome of electric industry restructuring.

John Nesbitt of Wisconsin Electric Co said that utilities should charge into distributed generation. Nesbitt said utilities generally need to use DG to optimize their distribution assets because the distribution company is now in competition with customer DG self-generation.

Jeff Ackerman of Colorado Public Service recommended installing renewables below the line to build market advantage, using government buy-downs or green contributions from customers. He recommended that utilities "get there first" before competitors try to sell green power to utility customers. (IPP does not support the utilities' "green pricing" but certainly DOES support self generation for intertied customers.)

Greg Hamm presented EPRI's study of DG within two restructuring scenarios: limited to wholesale only or opened to direct retail access. The study found that aggressive implementation of retail access affords the greatest prospect for maximizing distributed generation by end-users and independent generators. Retail access also maximizes distributed generation overall in the long run.

John Nimmons an attorney in Olympia, Washington, summarized an industry study titled, "Legal, Regulatory and Institutional Issues Facing Distributed Resources Development". He said the same unique advantages that utilities have in pursuing DG are also reasons that regulators may bar utilities from doing so. He stated that utility market entry into DG presents "a wide opening for the application of monopoly leveraging doctrine to regulated utilities."

Jay Morse of the California PUC presented a paper titled "The Distributed Generation Utility: A Restructured Perspective." Some of the paper's conclusions are:

- Regulated utilities are most likely to obtain regulatory approval to own DG on utility sites where the electric industry remains vertically integrated. However, with vertical unbundling, regulatory concerns mitigate against ownership by the regulated utility.
- Vertically integrated utilities may obtain approval for pilot programs to install, own or finance customer service DG (customer owned or located power generation connected on the customer side of the meter) if the pilot is conducted "below the line" or by an affiliate. The involvement of utilities or affiliates in on-site customer generation after vertical unbundling takes effect is unclear.
- Utility ownership of DG at customer locations connected on the utility side of the meter are least likely to obtain regulatory approval in either and integrated or restructured industry.
- Ownership of DG by a regulated utility is not compatible with vertical unbundling.
- Pressure for full retail access is overwhelming, particularly for commercial and industrial customers. Early in the next century, transmission grid companies and distribution line companies will become common carriers paid to deliver bulk and distributed power from competitive producers to consumers. Energy Service companies (Escos), retailcos, gencos and direct access providers will compete to provide distributed power from both sides of the meter to commercial and industrial customers. Under some scenarios, residential bypass will be on the horizon by 2006.

As the power transmission and distribution monopoly is broken by competition in transmission and from customer service DG, regulatory concerns about ownership of DG by gridcos and linecos may become moot.

Conclusions

At the closing panel of the conference, Tony Fung of UtiliCorp states, "Distributed generation is the only game where you can screw your neighbor. Therefore, for utilities, it is the only game in town." He added that deregulation means the commoditization of electricity. "Commodities are boring. They have low, low profit margins. In New Zealand, utilities have a lower margin

than supermarkets. The only way you can beef up your profits is by adding value at the customer site." He recommended that utilities "get into DG or your wires will be stranded. Join the revolution or the gas pipeline will be the vehicle for stealing your customers." We need say nothing more! Readers interested in a wealth of information about Restructuring, Distributed Generation and Net Metering should check out this web site. http://www.spratley.com/ncp/

I see a convergence of what used to be called Alternative Energy and what is now called Distributed Generation. Of course DG is not only renewables. One of the favored energy sources will be natural gas. Yes, it is carbon, but it burns cleaner than coal or oil. I am also hearing about a new gas engine cycle. The Entec system should improve efficiency. I'm thinking about gas lately because a lot of the PV systems I do are hybrids, using a propane or gasoline fired generator for backup. What I am realizing is that the generator is not used well. We should be recovering the exhaust heat! With the incorporation of cogeneration, I can visualize a distributed energy system consisting of solar thermal, cogeneration, photovoltaic and fuel. My feeling is that such a system will soon be cost effective, even connected to the grid. Load reduction, energy source diversity, energy efficiency and all the rest that used to be called Alternative Energy is now mainstream and called Distributed Generation!

And a Final Newsclip:
"Work Begins On Arizona's Tucson Electric Solar-Panel Plant", Phoenix Gazette, Dec 21 "Promising the greenest manufacturing site in Arizona, Tucson Electric Power Co. broke ground this week on its solar-panel production plant in Tucson. The $1.5 million facility, being built in a joint venture of TEP and its affiliate, Global Solar Energy LLC, is scheduled to be completed in May and begin production of advanced photovoltaic materials by June....TEP owns 50% of Global Solar. The venture is the result of a plan approved by the Arizona Corporation Commission in February to allow the utility to invest up to $25 million in energy related businesses as the industry is opened up to competition."

Competition? With whom? Sounds to us like TEPCO ratepayers are involuntarily financing TEPCOs power monopoly into the future. Such a deal....

Access
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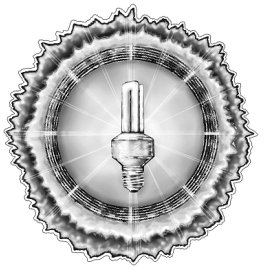
Home Power's Business



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Sir Thomas Lipton — 1870

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FLASH—KABOOM!

John Wiles

Sponsored By The Photovoltaic Systems Assistance Center
Sandia National Laboratories

It was a dark and stormy day many years ago. As I sat in my office overlooking the grounds of the United States Naval Academy, I could see lightning striking frequently throughout the area. Peals of thunder sounding shortly after the flashes indicated that the strikes were nearby. Suddenly the telephone rang; it was my wife. She said that the PV inverter was on fire and that the lights were out in our two-bedroom townhouse.

She told me that she had been sitting in the living room talking quietly with a friend when—Kabam!, lightning stuck in back of the house and the inverter appeared to be on fire. The noise and the fire had certainly unnerved them both. I asked if the fire was still going or if there was any need to call the fire department. She said that the ball of fire around the inverter lasted only a few seconds, but seemed like an eternity, and that there appeared to be no damage to the room. I asked if there was much smoke. She said that there was no smoke, but that there was a very pungent smell in the room for several minutes and the power seemed to be off on the circuits that were fed by the inverter.

I immediately went home to survey the damage. The inverter was indeed dead. After reviewing the details of the event and discussing them with my wife, I came to the following conclusions.

Analysis

Lightning had struck near or on the PV modules mounted on the fence in the small back yard. A surge of ball lightning had entered the house and settled on the inverter, an event that did the internal electronic components no good at all. The pungent smell was from ozone created by the ball lightning. Why did this happen and could it have been prevented?

The frame grounding for the modules was accomplished by using the bare grounding conductor in a number 10-2 with ground sheathed UF cable that was used to carry current from the modules to the power center. This equipment grounding conductor was connected to the grounding hole on each of the module frames and was then connected to the power center in a corner of the living room. From that location, a number 2/0 AWG grounding electrode cable was run back outside the house to a ground rod in the back yard—all according to the 1984 National Electrical Code (NEC). In this tiny townhouse, there was no garage or spare room to mount the power center, the inverter, or the batteries in any other location than in a corner of the living room. The batteries were in an outside-vented container and therefore they were protected from the fireball on the nearby inverter.

The nearby or possibly direct lightning strike had induced a large surge current into the equipment grounding conductors from the modules to the power center. The surge currents may have also been induced into the positive and negative current-carrying conductors, but there was no damage in the power center to indicate that this had occurred. Since the module frames were not otherwise grounded, the surge of current, and the ball lightning, traveled down the conductors from the PV modules into the house and then finally back out of the house to the ground rod and earth. The case of the 2500-watt inverter represented a large grounded surface and for unknown reasons, the ball lightning evidenced itself by settling on the inverter for a few seconds.

Solutions

The NEC provides little guidance in this area with only a brief mention of lightning arrestors in Article 280. See recent articles in Home Power Magazine and Access for other sources of information on surge arrestors.

Better grounding is the first solution that should be addressed in areas where lightning is common. PV modules are usually mounted high, in open areas to prevent shading from nearby objects. They resemble lightning rods and should be treated as such. Section 250-57 (b) Exception 2 of the NEC allows the equipment grounding conductor on DC circuits to be run separately from the current-carrying conductors. This was the first step that I took to protect my PV system, my family, and my home from lightning strikes.

I drove three 8-foot ground rods directly under the PV modules. The frame of each PV module was connected by a number 6 AWG bare copper conductor directly to the nearest ground rod with appropriate clamps on each end. Each of these new ground rods was connected (bonded) to the original main ground rod

with a number 2 AWG bare copper wire buried two feet in the ground. The equipment grounding conductor in the UF cable was disconnected at both ends. These changes allowed any direct lightning hits or induced currents in the PV module frames to be directly shunted to the earth. By disconnecting the equipment grounding conductor in the UF cable, surges previously traveling along it could no longer be induced into the adjacent current-carrying conductors. The NEC requires that the ground rods be bonded and this bonding forms a far more effective grounding system than a single rod. The rods should be at least six feet apart to meet the requirements of Section 250-84 of the NEC.

The next action that I took was to minimize the potential for damage that might occur if surge currents were induced on the positive and negative current-carrying conductors from the modules to the power center.

Near the modules, I mounted a 4" x 4" x 8"'/ metal enclosure (NEMA 3R junction box). In this enclosure, I mounted a listed, heavy-duty terminal strip (power distribution block) with three sets of feed-through compression terminals. The positive, and negative conductors from the PV modules, and a grounded conductor (to the ground rod) were connected to these three terminals. The case of the enclosure was connected to the number 6 AWG bare copper conductor going to the ground rod. Between each pair of these terminals (positive-to-negative, positive-to-ground, and negative-to-ground), I connected a metal oxide varistor (MOV) rated at twice the open-circuit voltage of my PV array. MOVs are usually protected with a fuse because they eventually fail in a short-circuit mode and then burn, but these were mounted in a metal box outdoors so the inevitable damage would be safely contained. These MOVs were later replaced with silicon oxide varistors (SOV) which, while taking up more space, do not fail in a short-circuit mode and can handle far greater surges.

I also connected pieces of number 10 AWG solid bare wire between these pairs of terminals. The wires were cut in the middle and the cut ends positioned as closely as possible without touching. These cut wires create spark gaps that provide a place for surge currents to jump to ground before they can harm other parts of the system. A surge suppression device at this location will protect the modules to some extent from induced surges and limit the magnitude of the surge currents reaching the power center.

At the location where the module conductors entered the house, a second enclosure was mounted containing the same components as the one at the modules. Surge suppression at this point should keep surges out of the house and is a requirement in the NEC that applies to telephone, cable TV, and antenna conductors. Since PV arrays are mounted in similar locations and are exposed to similar hazards, the conductors from the arrays should have surge suppression at the entrance to the building. All grounds for all conductors entering a building (PV, ac power, telephone, ham radio, TV, etc.) should be tied to the same grounding system.

As a final protection at the power center, I installed SOV surge suppressors on each circuit going to the PV array. These SOVs were connected between positive, negative, and ground conductors. Unfused MOVs should never be used inside a building where there is danger of fire.

The main grounding lug in the power center was connected to the nearest ground rod with a number 2/0 AWG conductor. The 1996 NEC requires only a number 6 AWG conductor for most installations. In the power center, the negative conductor of this 24-volt system was connected to the grounding system as the single-point DC ground for the system. Note that even though the DC conductor is grounded, it still receives the same surge protection as the ungrounded positive conductor. This is because there is considerable inductance in this grounded lead which is subject to induced surges.

Even now, when I am at home and the storms are coming (usually at night), I open the PV subarray circuit breakers and the main PV disconnect circuit breaker to provide even more isolation from unwanted electrical surges and even fire balls.

Additional Measures

Lightning rods can be placed behind the north sides of the PV array, but a professional lightning system installer should be consulted. Tall poles with a grounded conductor strung between them have been placed to either side of the array. The shadow caused by the wire on the PV array must be small enough to not cause significant loss of power. Above-ground conductors from the array can be installed in grounded metallic conduit. Commercial surge suppressors used by the TELCOM and TV broadcast industries could be used. PV conductors may be wound around a 1” x 12” steel pipe to form an inductance that may reduce the magnitude of the surges. In very bad conditions, some sort of plug and socket arrangement might be used to physically disconnect and separate the PV conductors from the building.

Summary

Little can be done to protect the PV system from a direct lightning strike that gets past modest amounts of surge protection. Dealing with nearby surges is a case of paying more money and installing more surge suppression to increase levels of protection.

Questions or Comments?
If you have questions about the NEC or the implementation of PV systems following the requirements of the NEC, feel free to call, fax, or write me at the location below. Sandia National Laboratories sponsors my activities in this area as a support function to the PV Industry.

Access
Author: John C. Wiles, Southwest Technology Development Institute, New Mexico State University, Box 30,001/ Department 3 SOLAR, Las Cruces, NM 88003 • Phone 505-646-6105 • FAX 505-646-3841

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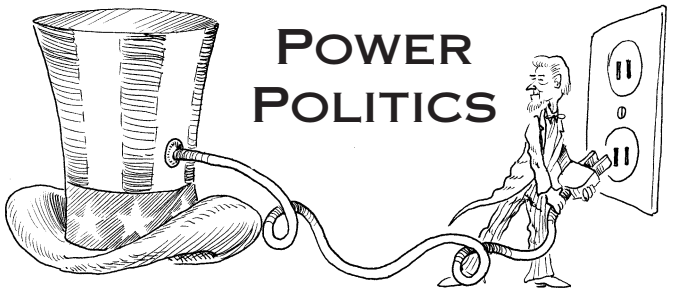
MOV Surge Arrestors are available from Digi-Key Corporation, 701 Brooks Ave. South, Thief River Falls, MN 56701-0677 • 800-344-4539 • http://www.digikey.com

SOV Surge Arrestors are available from Delta Lightning Arrestors, Inc. PO Box 1084, Big Spring, TX 79721 • 800-351-1464



Corporate Democracy

Michael Welch

Does our Constitution say that the U.S. government is "of the corporation, for the corporation, and by the corporation?" It doesn't, but over 100 years ago the U.S. Supreme Court decreed that corporations are to be considered persons under the law.

The corporation has become the voter of today. Politicians have figured out that they no longer have to win votes with grass roots effort. They can buy votes by spending incredible amounts of money on media campaigns. These kinds of campaigns cost several dollars per vote attained. That kind of money can only come from the corporate world.

Energy policy is probably the ultimate example of the ill effects of our corporate democracy. What is coming out of federal and state governments is not what the public wants placed into law. The facts and figures come from a November 1996 survey entitled "America Speaks Out on Energy: A Survey of 1996 Post-Election Views." Republican polling firm Research/Strategy/ Management was retained to do the work.

66% of those responding would give the highest priority for DOE R&D funding to renewables and energy efficiency. 56% of those that voted responded the same way. That's an awful lot if you remember that politicians consider it a "mandate" for their policies when they win by 4 to 5%. So RE has a HUGE mandate under that definition, yet is largely ignored. Why? the influential corporations in the fields of RE are few and far between. And those that are influential are very much involved in the highly profitable fossil fuel and/or nuclear fields.

When asked which R&D programs should be the first to be cut from the DOE budget, 31% said nuclear and 21% said fossil fuel. Once again, what is happening in Congress does not reflect what the people and the voters want. It is what the corporations want.

73% of respondents say that they base their Congressional choices at least in part on willingness to cut taxes. Congress has used this public desire to cut and slash away at many programs. But, if you'll notice, the programs cut are not the ones that help out corporations. They are also not the ones that most people want cut. 62% of respondents support tax incentives for RE and efficiency. An astounding 83% noted their preference for redirecting tax breaks to renewable fuels while only 10% felt they should continue to be given to oil companies.

71% of voters said they viewed global climate change as a serious threat. (See John Schaefer's article on page 39) Yet the government seems unwilling to do anything significant about it. Corporate polluters have paid for their candidates, and are getting their money's worth.

Restructuring

Utility restructuring is also being driven by corporate influence. They want cheap rates, no matter what is good for the public, environment, and voters. For many years the public has been in favor of a choice between electricity suppliers, but it wasn't until the huge manufacturing and resource extraction industries wanted cheaper rates that such a choice started moving forward. The unspoken result is that if electricity suppliers (also big corporations) are allowed to make the same profits as before (and they will be) and the big corporate customers are going to be getting cheaper power, then somebody is going to have to pay more to make up the difference. Who will that be? Right, we the people.

The corporate utilities are also getting their way under restructuring. They want customers to pay for their poor investment decisions in building uneconomic power generation facilities like nuclear plants. But, a lopsided 70% of the people polled feel that the utility companies and their shareholders should have to pay the debt on these plants that cannot compete in an open market. Only 14% thought those costs should be recovered from customers. Only another 8% thought they should be recovered from the tax base rather than the ratepayers.

Corporations are People too

As mentioned, corporations have been given legal status as persons. That entitles them to freedom of speech and the other Constitutional protections that the rest of us have. As "persons," corporations have exercised and vehemently protected their "rights" to interfere in elections, lawmaking, in our courts, and in our policy debates.

Of course, corporations couldn't overwhelm populace rule if they did not have the kind of resources they have at their disposal. You or I can call staffpersons for Congress or the President about an issue, but the corporation can hire a bevy of lobbyists to be on Capital Hill full time. Or they can give so much money to a political party that their CEO or Chairman is invited to spend the night in one of the guest rooms at the White House.

There are other areas where that huge resource comes into play. When the government needs or wants to protect the environment, public health, or workers' rights, corporations use their extensive wealth and influence to fight those laws tooth and nail. They call it "takings" and hide behind the banner of "property rights" and an individual's Constitutional right to redress. And they often get their way, only because they have the resources to do it. It's kind of like OJ's resources—guilty or not, it was universally recognized that hiring the best attorneys in the world was likely to get him off.

Strategy #2

Regular readers of this column have often heard my opinion that the only way to make our government responsive to the needs of the citizens is through campaign finance and lobby reforms. It is still necessary to follow through on these things, but there is another tool that needs to be pursued. We need to cut off corporate power at its source.

Nation wide efforts are under way to change the legal doctrines and laws which give corporations overwhelming advantage over people, communities, and nature. We must overturn the precedent that the corporations are treated as persons under the law. This one huge step will do more for the environment and the health and well being of all our planet's inhabitants than any other law or regulation.

The right to redefine the status of corporations still rests with us. It will be very difficult, but it is time to start educating and talking among ourselves about reclaiming peoples' rights back from the corporate thieves.

Of course, not all corporations are bad. For example, this magazine is published by a closely held corporation whose primary motivations are not profit-making (although HP certainly couldn't do this without pay). The evil comes into play when any business or individual operates purely on the motive of profit without dealing with the side effects of making those profits.

It's just a lot more likely to happen with publicly traded corporations. They have no conscience. Even the collective good ethics of all the corporate shareholders is kept out of the business decision-making. The heads of such a corporation are held to one standard only: make as much profit as possible for the shareholders. If they don't, they go down the road. These are the kinds of people that are making important daily decisions about our environment, health, safety, and economy.

Other less ominous corporations include non-profits that are required by law to incorporate before they qualify for tax exemption. And closely held corporations are not allowed to sell and trade stock on the open market, so they can maintain the conscience of the handful of owners that started the business.

It is time to find out more about how we can stop the corporate takeover of our freedoms and rights. Contact Richard Grossman of the Program on Corporations, Law and Democracy (POCLAD) for information and educational materials that can help us get back our due.

Access

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Phone/fax 508-487-3151

For a copy of the 130+ page results, including demographics, of the survey “America Speaks Out on Energy” send $25 to Sustainable Energy Coalition 315 Circle Ave. #2, Takoma Park, MD 20912
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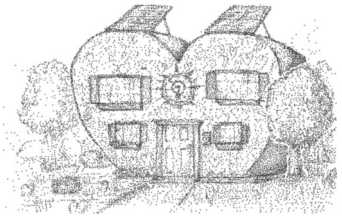
Home & Heart



Kathleen Jarschke-Schultze

When I was in the fourth grade my brother, Mike, and I went to a rural two room school. Our school was visited by the Space Van from NASA. These two guys from the Space Center went around to schools and explained elementary technology to children. They told us about the big computers at NASA and how some day we would all use computers. Boy, were we impressed.

Then and Now

I told that little story to a classroom of fourth grade youngsters this September. As I spoke I looked around and sure enough there was a computer on the counter next to me. For those kids computers are common place.

I was there in my niece Tesla's class to do a solar cooking demonstration. "That guy was right," I said. "And when you grow up and live on renewable energy and cook with the sun you'll remember today and tell your kids about it."

Teach and Learn

Since I was going to visit my siblings I called my brother Gene to see if Tesla's teacher would like me to demonstrate cooking with the sun. He said at a recent open house night the teacher had invited any parent who had a special talent or hobby to visit the classroom.

I loaded up my Solar Chef cooker and a small Sunspot along with all my junk into the old station wagon. I knew I could borrow my sister Tammy's Burns Milwaukee Sun Oven. That gave me three different size and shaped solar cookers. I also brought a solar flashlight that we found at Costco for under twenty bucks. It has solar cells on the side panel. With it, I could show the kids the solar cells, then immediately show them how the power from the sun stored in the battery inside could turn the light on.

Teacher Learning

Gene sent a note to Tesla's teacher. She called Gene to set up a time and place for the demonstration. Gene thought the playground blacktop would be a good place. "No," the teacher said, "I think it would be better to set up in the field directly behind the classroom. That way we can run an extension cord out the window for her oven." Gene bit his tongue but warned me the kids weren't the only ones I'd be teaching.

Solor Muffins

When I demonstrate a solar oven I usually cook little muffins in their own cupcake papers. If you mix the muffin batter in a large freezer bag you can cut a corner off and fill each muffin cup easily and with a minimum of mess. There is something about rising bread that is very impressive. The muffins don't take long to cook and smell and taste great.

Once when I was baking muffins at a solar fair this guy comes by and says,"So theoretically this oven is going to cook those muffins." "Sure", I said, "come back in ten minutes and eat a theoretical muffin."

I started the muffins in the three cookers then went to the classroom. After a short talk about renewable energy and how my home system worked we had a question and answer period. Some of the kids were asking very good questions. Does it take longer to cook in a solar oven than in a regular one? Can you cook potatoes? Some of the kids didn't quite get it. I talked about the Sunspot, how it was taken on expeditions up Mt. Everest to melt snow for water and that it weighed only three pounds. One girl raised her hand and waved it excitedly. I called on her. "I only weighed three pounds when I was born." she announced.

Out in the Sun

We all trooped outside to see the cookers and eat the muffins. The kids were very excited and crowded around the ovens. You could smell the banana nut muffins and see them raising and browning. It was the kids lunchtime so they went to eat lunch. Afterward they trickled back a few at a time to get a solar muffin for dessert.

I was standing there talking with the teacher telling her more about our power system at home. She asked me how much was my utility bill every month. I paused. She caught herself before I could answer. I am always surprised at how much people don't know about renewables.

Much Thanks

A couple of weeks after I got back home I got and envelope from the class in Room 20. The teacher had the children write me thank you notes for my visit. She wrote this note on top.

Kathy, 'Letter writing' is not a time I modify english or correct spelling. I tell the children to use the dictionary and ask one another. I think the letters that result are far more endearing and from the heart. Read on. Ms. Erickson

My Favorites
Dear Kathy, thank you for coming and showing us the solar ovens. and one more thing thank you for a treat!!!!!! your freind, Ben

Dear Kathy, I like your solar demonstration it was fun and interesting and the solar cooked muffins where good. I liked your big solar oven because it was awesome have a safe trip home and thank you very much. Love, Luis (This kid asked the best questions. I predict a great future for Luis.)

Dear Kathy, Thank you for showing us how to cook solor muffuins and I hope you can visit us again mabe you cold cook cup kicks bring the frost. I hope you have a nice trip. your Friend Ernesto

Dear Aunt Kathy, Thank you for comeing to my room and bakeing those delicious muffins. It was so neat to eat a soler meal on Sunday. Thank you ever so much. Love, Tesla (I cooked a chicken dinner for my brother's family that Sunday.)

Dear Kathy, Thank you very much for coming in Our class. That was very cool thanks again now my mom can do a solar oven. Be cool and be safe. The muffins were delicious. Come again some day. Love Student, Edith

Conclusion
If you have children in school, or nieces and nephews, or neighbor kids, volunteer to tell them about the renewable energy part of your life. You will always get back more than you give. You don't have to be professional, just be yourself. All you need are a few props or a home drawn poster. Take a few copies of *Home Power.* Teachers, Den Mothers, Troop Leaders will welcome you. The kids will love you. Look at all my new friends.

Access
Kathleen Jarschke-Schultze is testing her new bread machine at her home in northern-most California, c/o Home Power Magazine, POB 520, Ashland, OR 97520 916•475-0830 Internet Email: kathleen.jarschke-schultze@homepower.org or kjs@snowcrest.net

Adopt a Library!

When Karen and I were living with kerosene lamps, we went to our local public library to find out if there was a better way to light up our nights. We found nothing about small scale renewable energy.

One of the first things we did when we started publishing this magazine seven years ago was to give a subscription to our local public library.

You may want to do the same for your local public library. We'll split the cost (50/50) of the sub with you if you do. You pay $11.25 and Home Power will pay the rest. If your public library is outside of the USA, then we'll split the sub to your location so call for rates.

Please check with your public library before sending them a sub. Some rural libraries may not have space, so check with your librarian before adopting your local public library. Sorry, private or corporate libraries are not eligible for this Adopt a Library deal—the library must give free public access. — Richard Perez

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HAPPENINGS

CANADA
The "Alberta Sustainable House" is now open for public viewing every Saturday 1:00-4:00 PM free of charge. The first of its kind in Canada, the project emphasizes cold-climate state-of-the-art features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada; 403-239-1882, Fax: 403-547-2671

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For more info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada; 902-892-9578.

23rd Annual Conference of the Solar Energy Society of Canada, June 5–7, 1997, Vancouver, British Columbia. Topics will include: housing & building, solar thermal, PV, other sustainable technologies, economics, policy & business, transportation & education. For more info contact:Solar Energy Society of Canada Inc. (SESCI), 2nd Floor, 2415 Holly Ln, Ottawa, Ontario K1V 7P2, Canada • phone 613-523-0974 • 613-736-8938 • e-mail: solar@worldlink.ca • web site: http://www.newenergy.org/newenergy/sesci.html

GREECE
1st European Conference on Clean Cars & 1st Hellenic ECO Rally, Athens Greece • Fax +301 772-2028

INDIA
International Conference and Exhibition on Village Electrification Through Renewable Energy, March 3–5, 1997, New Delhi, India. The Conference and Exhibition will cover photovoltaic systems, wind systems, remote area power supplies, mini/micro hydro, solar thermal, health, biomass, biogas, rural communications, project management, remote monitoring, and financing renewable energy projects. The Conference will provide an excellent opportunity to meet with the Indian Government, World Bank, and GEF officials, researchers, project developers and financiers and the leading players in the field of renewable energy. For more information contact: Dr Dilawar Singh, Co-chairman, c/CASE, Level 3, 81 St Georges Terrace, Perth, Western Australia 6000, Australia, phone (+619) 321 7600, Fax (+691) 321 7497. E-mail: case@wantree.com.au

INDONESIA
The Asia-Pacific Initiative for Renewable Energy and Energy Efficiency Event '97, October 14–16, 1997, Jakarta Convention Center. The Event will bring together the largest collection of alternative energy and energy efficiency companies in Asia. The conference will include top speakers and focus on marketing strategies, project financing, policies and incentives for implementation of renewable energy and energy efficiency projects in the Asia-Pacific region. For more information contact:Alternative Development Asia Limited, 5/F 3 Wood Rd, Wanchai, Hong Kong •phone + 852 2574 9133 • Fax +852 2574 1997 • e-mail: altdev@hk.super.net • website: http://www.hk.super.net/~altdev/

SPAIN
14th European Photovoltaic Solar Energy Conference and Exhibition, which will be held at the Palacio de Congresos in Barcelona (Catalunya), Spain from June 30th to July 4th 1997.

To receive more information about the Conference please contact: 20 WIP, Sylvensteinstr. 2, D-81369 M FCnchen, Germany, Phone +49 89 720 1232,Fax +49 89 720 1291, E-mail: renewables@mail.tnet.de • Information also available at www.wip.tnet.de

UNITED ARAB EMIRATES
The Gulf Enviro Show and The Middle East Alternative Energy Exhibition, 17–20 1997, Abu Dhabi International Exhibition Centre. This event is unlike anything else that has taken place in the Arab world! There will be four important sectors: agriculture and fisheries, water supply, environmental protection and alternative energy, which are pertinent to the whole of the Arabian Peninsula. For more information contact: Solstice Int., PO Box 51841, Dubai, United Arab Emirates • phone 011-971-4-317458 • Fax 011-971-4-314071

UNITED KINGDOM
Weekend Workshops! Have you wanted to build a wind generator, solar PV, water heating system or any alternative technology project? Don't know how or where to start or have no workshop available. Working with other people of varying ability in a well equipped workshop can solve the problems! A series of practical workshops are being held by Robert Keyes GW4IED, of Keystone Systems working from plans or to your design. Held in Newport close to the M4 J25, Saturday 12–6, Sunday 9–4 with hotel & B/B close by, hard standing suitable for caravans available on site. Running throughout 1997. Tel/fax 01633 280958 during office hours for more info.

NATIONAL
Online Energy Info Resources—If you are looking for information on energy efficiency or renewable energy technologies, the US Department of Energy (DOE) has two sources of online access. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) BBS Online Service offers users free access to text files, share and freeware programs and utilities, and a free publication ordering system. The service is accessible via the Internet's World Wide Web at http://erecbbs.nciinc.com or by modem at (800) 273-2955. The Energy Efficiency and Renewable Energy Network (EREN) is also accessible on the World Wide Web at http://www.eren.doe.gov and provides links to hundreds of government and private internet sites. EREN also offers an "Ask an Energy Expert" online form that allows users to e-mail their questions directly to specialists at EREC. For more information please call (800) 363-3732.

American Hydrogen Association, national headquarters, 216 South Clark Dr, Ste 103, Tempe, AZ 85281, 602-921-0433, fax 602-967-6601, e-mail: aha@getnet.com "Prosperity Without Pollution" web site: http://www.getnet.com/charity/aha

Energy Efficiency and Renewable Energy Clearinghouse (EREC) is offering free information on Clean Energy for a Competitive America! Learn how to use energy more efficiently. The Department of Energy offers FREE information on topics such as windows, lighting, insulation and tips for energy savers. You can save energy in every room in your house and get advise on major appliances and heating and cooling. Also available—Get the fuel economy ratings of the new 1997 model cars! The DOE and the Environmental Protection Agency jointly produce a Free publication The 1997 Fuel Economy Guide (SD397). The guide offers information on most 1997 model vehicles including cars, light trucks, and vans. It provides you with estimated miles per gallon based on engine size and transmission type. Also available: Heating the Home (FS236) information on improving the efficiency of your electric, gas or oil heating system. To obtain your free copy contact EREC: Phone: 800-DOE-EREC (363-3732); mail: EREC, PO Box 3048, Merrifield, VA 22116; e-mail: energyinfo@delphi.com; TDD: 800-273-2957; The information can also be downloaded via the DOE's BBS at 800-273-2955 or via internet: http://www.eren.doe.gov

Visit AWEA's (American Wind Energy Association) home page on the World Wide Web. (http://www.igc.apc.org/awea) Visitors to AWEA's home page can obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

Tesla Engine Builders Association (TEBA) provides information about a practical and efficient steam turbine available to the home power producer. The "Tesla Turbine" is the only high power turbine that can be constructed using only simple machining techniques and can operate satisfactorily using only 100 lbs of steam pressure. For more information send an SASE to: TEBA, 5464 N POrt Washington Rd Ste 293, Milwaukee WI 53217-4925; or visit our WWW site: http://www.execpc.com/~teba or send e-mail to: teba@execpc.com

Last year's American Solar Energy Society & USDOE's & Interstate Renewable Energy Council National Tour of Solar Homes was a great success. To participate in the 1997 event (October 18) contact: American Solar Energy Society, 2400 Central Ave Ste G-1, Boulder, CO 80301 • phone 303-443-3130 • website: http://www.ases.org/solar/

NORTHEAST UNITED STATES
Ninth Annual NESEA American Tour de Sol, US Road Rally Championship for Electric Vehicles, May 17–24, 1997, Waterbury, CT to Portland, ME. For more information on entering or watching the show contact: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

ARIZONA
Solar energy for environmental education! Come join Solar Energy International (SEI) in beautiful Flagstaff, Arizona. SEI announces a photovoltaic design and installation workshop to be held April 28th through May 3rd at Camp Colton Environmental Education Center, located in the pines and aspens at 8800 feet just ten miles from downtown Flagstaff. Thousands of school children

spend one full week of their school year at the camp learning about our environment. During the workshop participants will install a PV system to power up the camp lodge. Lodging is available on the site and included in the tuition. Four days of lecture and lab with two days of hands-on instruction. Tuition is $500.00. For more info:Solar Energy International, PO Box 715, Carbondale, CO 81623, tel. 970-963-8855, Fax 970-963-8866, E-Mail—sei@solarenergy.org

The State of Arizona is now offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the Arizona Department of Commerce must be on each job site. For info contact ARI SEIA; 602-258-3422.

Power the Parks! Solar Energy International announces a special workshop for Park Service personnel. This workshop will be held in beautiful Red Rock State Park in Sedona, Arizona, March 17–22, 1997. Camping on site is available. Workshop topics will be based on applications for park energy needs. Sign lighting, water pumping, restrooms, residences, gate entry systems and more will ne covered. Hands-on, lecture and labs are scheduled This workshop is open to the general public also. Tution is $500.00. For more information call or write: Solar Energy International, PO Box 715, Carbondale, CO 81623, tel. 970-963-8855, Fax 970-963-8866, E-Mail—sei@solarenergy.org

ARKANSAS
Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. Their focus is to teach home building from materials that can last a thousand years and cost less than conventional wood-framing. These are hands-on, all-day workshops. Contact Loren at PO Box 453, Hot Springs, AR 71902.

CALIFORNIA
Offline will have an Introductory Residential PV Design workshop on March 15, 1997 this workshop is for beginners and will held at the rustic and remote home/office of Offline. It is for one day and it costs $35. Enrollment is limited. Please call 209 877 7080 for more details and directions or Email: ofln@aol.com

A special Advanced Hands-On will be on June 14 and 15, 1997. The Advanced workshop will be held at Sun Mountain Tollhouse, California. Participants in this workshop will upgrade the existing PV system at Sun Mountain. We will install an APT Powercenter in addition to re-wiring the existing modules and powerhouse to current NEC standards. This workshop is appropriate for the person who knows they will install their own system. The cost for the Advanced is $250 and includes lodging. Enrollment is limited to 10, so please enroll early. Call or Email Offline (see above) for more details.The Advanced workshop is a benefit for and part of a Straw Bale project at Sun Mountain. If you are also interested in Straw Bale construction, call George Ballis at 209 855 3710.

COLORADO
Solar Energy International (SEI) is offering "hands-on" workshops on the practical use of solar, wind, and water power. The Renewable Energy Education Program (REEP) features one and two week sessions, PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Solar Home Design, Cob & Natural Building, Straw-Bale Construction and Adobe/Rammed Earth. Experienced instructors and industry representatives teach how to build homes and RE systems. Learn in classroom, laboratory and through field work. The workshop series is for owner-builders, industry technicians, business owners, career seekers and international development workers. The small, intensive and fun workshops may be taken individually or as a comprehensive program. The cost is $450.00 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden, CO. The facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900, Fax 303-384-6901.

CONNECTICUT
Building Energy '97: Insuring a Sustainable Future; Two Conferences, Workshops and a Trade Show. NESEA's Quality Building Conference and NESEA's RENEW '97 will bring together experts and decision makers from the advanced building and renewable energy industries to describe how quality construction practice, emerging technologies and global market opportunities will shape communities of the future.

Building Energy '97 will provide a launching point for sustainable development in the next millennium, emphasizing green buildings and renewable energy as the foundation. Architects and builders, code officials, land-use planners and landscape architects will discuss how communities can work together to make sustainable development standard practice. For the first time insurance and financial experts will participate in the analysis of renewable energy and sustainable building not only as strategies for loss mitigation, but as the key investment opportunity for "insuring the future."

Renew '97 will focus on the latest developments in renewable technologies in the context of real market applications, highlighting how they can find a niche in an evolving utility environment as well as a booming global marketplace. For more information contact: NESEA, 50 Miles St, Greenfield, MA 01301-93212, 413-774-6051, fax 413-774-6053.

FLORIDA
The First South Florida Sustainable Building Conference and Exhibition, April 10–12, 1997: For building professionals, regulators, researchers and users. Workshops, seminars and exhibits covering sustainability issues in the planning, design, construction, operation and demolition/or recycling of commercial and residential buildings. For more information call (305) 375-1150, fax (305) 375-1157.

14th International Electric Vehicle Symposium, December 15–17, 1997, Walt Disney World Dolphin, Orlando, FL. Call for papers by Feb. 14.1997. For more information on submitting an abstracts or attending or exhibiting contact: Pan Turner, EVS-14 Symposium Manager, c/o First Option, 15 N Ellsworth Ave Ste 202, San Mateo, CA 94401 • phone 415-548-0311 • fax 415-548-9764 • e-mail: firstopt@aol.com

GEORGIA
Photovoltaic Technology and Applications, April 15–17, 1997, Atlanta, Georgia. This course broadly examines photovoltaic (PV) technologies and applications from basic properties of sunlight and PV conversion to the design and modeling of PV systems. Other issues in PV technologies and use will be discussed including cost considerations and building integration. As a special feature of this course, students will visit and study the Georgia Tech Olympic Aquatic Center which features a large roof-mounted PV system. This course is conducted by: Georgia Tech Continuing Education. Program Fee: $975. For more information: Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332-0385 • phone 404-894-2547 • e-mail: conted@gatech.edu • web: http://www.conted.gatech.edu

Photovoltaic Design and Installation! Solar Energy International (SEI) announces a hands-on, how-to workshop in Atlanta, GA, April 7–12,1997 at the Southface Energy and Environmental Resource Center. The workshop in being held in cooperation with Southface Energy Institute of Atlanta, a non-profit organization performing research, education and consulting on energy and environmental technologies. The tution for all six days is $500. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience or training is necessary—everyone is welcome. For more information contact: Solar Energy International, PO Box 715, Carbondale, CO 81623, tel. 970-963-8855, Fax 970-963-8866, E-Mail—sei@solarenergy.org

MASSACHUSETTS
NESEA is converting its headquarters into a showcase of environmentally responsive building appropriate to the 21st century. NESEA members are converting a historic railroad hub into a working demonstration of a healthy, daylit, office building flanked by a park which celebrates transportation history while demonstrating principles of urban ecology. Opportunities for involvement include • Saturdays at NESEA: A volunteer program through which construction novices learn green building tricks of the trades working with professionals. • Major transformations of the building and park will be undertaken as "barn-raisings." For more info contact. NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

MICHIGAN
EnV'97 Environmental Vehicles Conference & Expo, April 7–10, Detroit, MI • phone 810-355-2910 • fax 810-355-1492

MISSOURI
The Missouri Renewable Energy Association is a non-profit educational organization, promoting energy sensible technologies as a solution to global environmental pollution. Improved energy efficiency. water conservation, recycling, and composting are just a few of the topics on our agenda. We encourage local government, businesses, schools, and individuals to become involved by joining the MO.REA today. For information contact Ray Wathswski, PO Box 104582, Jefferson City, MO 65110, 573-634-5051

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516

Volunteers are sought for Seedcorn's 4th Alternative Energy Fair & Home Tours. The Fair will be held Saturday, April 26, 1997 in Potsdam, New York (3 hours north of Syracuse, near Cornwall, Ontario) with tours of AE homes on May 3rd & 4th. For info contact Chelle at 315-265-4619 • fax 315-268-1229 • e-mail: ewb.herd.org or write PO Box 5055, Potsdam, NY 13676.

NORTH CAROLINA
Wind Power Hands-on Workshop, April 7–12, 1997. Before you spend thousands on a wind system of your own, or if you're interested in learning to design and install wind electric generator systems.

If you want to get hands-on experience working with full-size wind machines. Participate in the installation of a real home power wind system from start to finish with special Guest teacher Mick Sagrillo. Give me (Lyn) a call here at the Solar Village Institute 910-376-9530 or write to: PO Box 14, Saxapahaw, NC 27340

OHIO
The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information: Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44, 614-899-6263, Fax 614-899-1717. Internet: DUSSAULT@delphi.com

Solar and wind classes taught at rural solar and wind powered home with utility back-up. Maximum of 12 students. Must advance register. $45.00 fee per person, $50 per couple and lunch is provided. Please advise of dietary restrictions. Class #1 will be full of technical info, system design, system sizing, and NEC compliance, etc. Students will see equipment in use. Dates: Every 2nd Saturday of each month. All classes held from 10:00 am-2:00 pm on Saturday. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

OREGON
The Lane County College Energy Management Program is offering a Passive Solar Design course Winter Term 1997. course content: the physics of solar design, heat load calculations, solar gain, passive solar applications including direct, indirect, and isolated gain, plus shading and cooling design. The course will include a full day tour of local passive solar homes, both new and retrofit. The course will culminate in a design project of the student's choice using the Passive Solar Industries Council software "Passive Solar Design Strategies: Guidelines for Home Builders." Instructors for this course are Tom Scott and David Parker, co-owners of the Energy Service Company and Roger Ebbage, CEM, Coordinator of the Energy Management Program at Lane Community College in Eugene, Oregon. For further information please contact Roger Ebbage at Lane Community College, 541-747-4501 ext. 2451. Out of area call 800-769-9687. E-mail ebbager@lancc.edu or visit our web site at http://lanecc.edu:1080/webpages/lcc/science/home.htm

APROVECHO RESEARCH CENTER offers a ten week Internship Program in appropriate technology, sustainable forestry, organic gardening and indigenous skills. Applications are being accepted now for Spring term which begins March 1, 1997. Tution is $1500 and includes classes, a room in our new solar straw-bale dormitory and delicious all organic meals. Classes typically run from 8:30 am to 5:00 pm Monday through Friday, with plenty of hands-on experience combined with lectures, field trips and fun!

The appropriate technology course is divided into three parts: solar designing, bio-mass conversion and conducting research in these areas. Progressive reforestation techniques are studied and practiced, as well as the sustainable harvesting of forest products such as mushrooms, vine-maple for fencing and basketry, and herbs for medicinal and aesthetic purposes. More productive and integrative methods of farming, including permaculture, are also studied while working in our beautiful organic garden.

Aprovecho Research Center is a non-profit educational institute located on forty acres nestled deep in the forest of Oregon. Internship programs March 1, June 1 and September 1 of every year. We also offer a six week winter internship in Baja Mexico which focuses on studying and researching appropriate technology applications, learning Spanish, teaching in a grade school and working in fruit orchards and gardens. Call 541-942-8198 or write to: Internship Coordinator, Aprovecho Research Center, 80574 Hazelton Rd., Cottage Grove, OR 97424.

The Third Annual HOPES Eco-Design Arts Conference, April 11–13, 1997, Eugene, Oregon. This year's theme is Cultivating Communities and Helping Environments. For more info contact: HOPES, Lawrence Hall, 5249 University of Oregon, Eugene, Or 97403-5249 • phone: 541-346-0719 • e-mail: hopes@aaa.uoregon.edu • web site: http://gladstone.uoregon.edu:80/~ hopes/

VERMONT
Free PV Workshops for beginners to experienced given by David Palumbo of Independent Power & Light, first Saturday of most months at the Palumbo/IP&L PV and microhydro powered off-grid neighborhood. Participant interest will determine which of the following topics will be discussed and demonstrated (as practical): site selection, PV modules, batteries, safety, charge controllers, inverters, DC lighting, balance of system components, system monitoring and maintenance, water (finding it, developing it, transporting it, pumping it, and getting power from it), snow (living with it, playing with it, and removing it), ponds, living in cold climates, living with our woods, heating with wood, and root cellars. Visit a beautiful part of Vermont and meet people who are either living with renewable power or considering it. David Palumbo has taught workshops in the past with the fine people of Solar Energy International and with the real good folks of the Solar Living Institute.

Call, fax, or write schedule, reserved spot, and directions. 9 am to 3 pm the first Saturday of most months. David Palumbo/ Independent Power & Light, RR1 Box 3054, Hyde Park, VT 05655, call or fax 802-888-7194. This is a freebie so bring your own lunch and coffee.

VIRGINIA
2nd Industrial Energy Efficiency Symposium & Expo, February 24–26,1997, Arlington, Virginia. Sponsored ny the US DOE. For more information contact: Energetics Inc., 7164 Gateway Dr., Columbus, MD 21046 •phone: 410-290-0370, Fax: 301-621-3329

WASHINGTON, DC
SOLAR 97 American Solar Energy Society Conference. In conjunction with Soltech 97. For info: ASES 2400 Central Ave Suite G1, Boulder, CO 80301 • 303-443-3130 • ases@ases.org • http://www.ases.org/solar.

Solar Energy Forum, April 25–30, 1997, Washington DC. The combined annual solar events of: American Institute of Architects, American Society of Mechanical Engineers, American Solar Energy Society, Interstate Renewable Energy Council, Solar Energy Industries Assoc., Utility Photovoltaic Group, and the US Department of Energy. For more information contact: Michelle Birkenstock, SEIA, 202-383-2620, fax 202-383-2670 or Erin O'Donnell, UPVG, 202-857-0898, fax 202-223-5537.

WISCONSIN
The Midwest Renewable Energy Association Spring Workshop Schedule. Energy Efficient Construction Workshops: Hydronic Floor Heating: Feb. 8 • Energy Efficient Construction Techniques, Feb. 22–23 • A Day in the Dirt: Hands-On Experience with Earthen Floors, May 17. Renewable Energy Workshops: Basic Electricity, Feb. 15 • Renewable Energy 101, March 8 • Batteries and Inverters, March 22–23 • Introduction to Renewables April 5 • Basic Photovoltaics April 6 • Advanced Photovoltaics April 25–27 • Utility Intertie Wind Systems March 17–18. Sustainable Living Skills Workshops: Basic Organic Gardening March 15. Pre-Energy Fair Workshops: Off-Grid Wind Systems June 6–8 • Utility Intertie Wind Systems June 13–15 • Hands-On Photovoltaic Systems June 10–13 & 16–18. Call MREA for cost, locations, instructors and further workshop descriptions. Membership and participation in the MREA are open and welcome to all interested individuals and organizations. Significant others may attend with you for 1/2 price. For more information call or write MREA, PO Box 249, Amherst, WI 54406; phone 715-824-5166, fax 715-824-5399

the Wizard speaks…

ZPF Mechanisms

The zero point field (ZPF) is the basic energy field pervading all space. It is also called space energy, the energetic Aether, the vacuum field, etc. We need to know what processes and mechanisms we can use to extract energy from this field.

These mechanisms are essentially of two forms. These are ZPF scattering and ZPF coherence. Resonance is one key to their operation. It is based on a combination of phase, frequency, polarization, and amplitude.

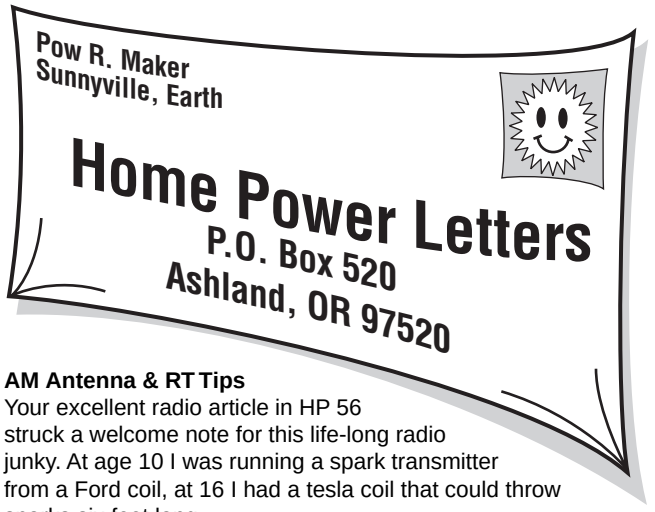
ZPF scattering occurs when the basic structure of the field is disrupted, usually by electromagnetic means. ZPF scattering will be most useful in manipulating gravity and inertia.

ZPF coherence occurs when the field structure is raised to a higher degree of order. Again, this is usually accomplished using electromagnetic fields. ZPF coherence will be most useful in generating heat, light, and electricity.

These two mechanisms and their associated processes can be the major building blocs of tomorrow's technology. When used in combination with other aspects of the emerging paradigm, they could produce an earthly paradise.

The cover tells a long fine tale
Of issues now and issues pale
A small white tag there does decry
How many more you have to fly

Check your mailing label!



AM Antenna & RT Tips

Your excellent radio article in HP 56 struck a welcome note for this life-long radio junky. At age 10 I was running a spark transmitter from a Ford coil, at 16 I had a tesla coil that could throw sparks six feet long.

The article also hit right home when it comes to dealing with radios, CBs and telephones in a remote area like McCarthy, Alaska. This I have lots of practice with and happily pass on some additional dope you might be able to use.

The secret to far fringe area AM reception is a good ground along with a long antenna. When you wrap the antenna lead a few times around an AM radio (insulated wire works better here), carry the loose end on to a good ground. This completes the RF circuit to induce a signal from the wrapped wire to the radio's loopstick. A more sophisticated version is a few turns of wire around a ferrite rod, connected to antenna and ground and strategically placed at the back of the radio as close as possible and parallel to the internal loopstick. In some locations, the Select-a-Tenna from C. Crane Company works pretty good....it tunes a resonant loop.

Actually there is a limit on how high a CB antenna can be—the FCC says 60 ft. But away off in the bush, in places like McCarthy and Agate Flat, fudging this limit is like hotrodding a wireless phone...who's to know the difference?

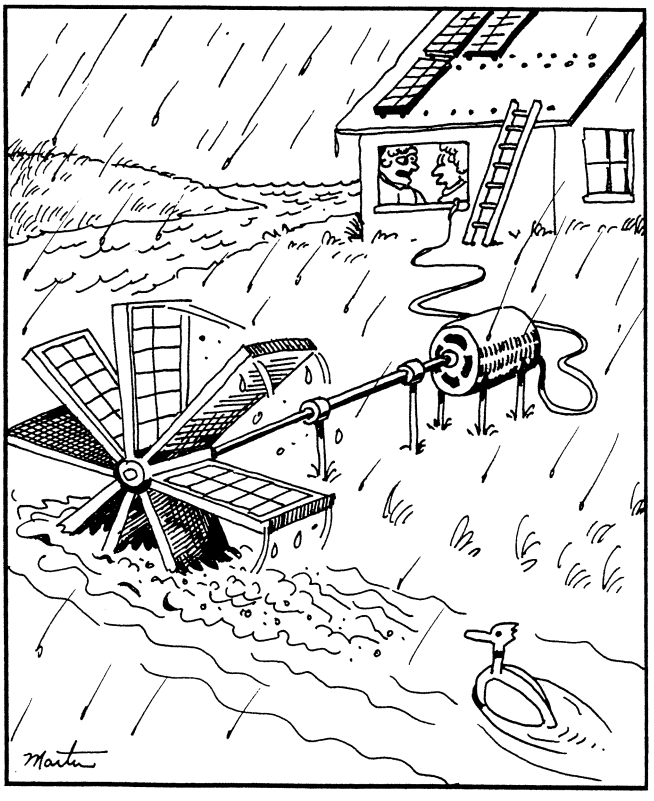
There is another way to get a phone in your house—the one we have in McCarthy. This is a cell-phone based technology called "residential service". Instead of a portable cell phone, you have a fixed installation bolted to the wall inside your house. You pay a fixed monthly rate (ours is $44/month plus long distance charges) but no by-the-minute air time. This is all done through the billing computer. Electronically, the cell site can't tell the difference between a portable cell-phone and the residential unit, which is built around Motorola mobile hardware. For various arcane reasons, including some billing peculiarities of our local phone company, I have a Motorola mobile unit (bag phone) in my house along with a pricey little modem adapter that Motorola calls "The Cellular Connection". This latter gadget is actually is a universal adapter that will connect a cell-phone to anything you can plug into a RJ-11 jack—modem, fax, regular telephone, etc. Useful gadget to know about—it's a little black box with an RJ-11 jack.

Here is one more AM antenna tip: We sometimes use what we call an "Alaskan Beveridge" antenna. This works best in soil conditions where it is hard to get a good ground, all too typical of Alaska's permafrost, glacial till and the like. Roll out a long length of insulated wire on the ground in the direction of the station you want to receive. Roll out a second long length in the opposite direction. Bring the two adjacent ends to your AM radio and connect to whatever kind of coupling coil you have constructed (the ferrite rod works best).

#12 house wire is cheap in 500-foot rolls and works well for this. The orientation of the wires is important. If you get them at right angles to the line pointing at the target station, the reception is very poor. Obviously this system doesn't work if you want reception from several different stations. Our local community FM radio, KXKM, is fed by picking up the signal this way from public radio KCHU in Valdez 150 miles away. The receiver is a Sony 2010. The forward half of the antenna is 2000 ft long, the back half 1000 ft.

A merry Christmas and a joyous winter solstice to all at the Flat. We're hoping you weren't sloshed away by all that recent Oregon rain. Ed LaChapelle, McCarthy, Alaska e-mail: Edlach@aol.com

Thanks for the antenna tips, Ed. All types of radio reception are a challenge in the back country. You're right about the radio ground—it's every bit as important as the actual "in the air" antenna. Agate Flat is much closer to broadcast services than you are in McCarthy. The toughest RF problem here is VHF broadcast TV (forget UHF around here, too many mountains). Everyone around us has given up on broadcast TV and they are now using the micro-dish satellite TV systems. I just hooked up our 5 inch B/W TV this morning (1 January 1997). After over five years of not watching commercial TV, the recent heavy rains and local flooding prompted us to hook it up for the local TV news. Our home and office is located well above Skookum Creek, so we won't be washed away. Most of the low lying areas around us, however, are flooding as I write this. In times when Nature gets ugly, electric power and communications become essential. I



"It's been raining for two months now, he had to do *something* with those PV panels."

know that any Home Power reader who has listened or watched a local disaster on RE-powered comm gear can appreciate how important independently-powered, communications is. Richard Perez

World's Apart

Reading Home Power is a special treat, only implementing your ideas and recommendations has taught me that the States are a world apart, or Tanzania is a world apart.

From Alternative Energy Engineering, Redway, California I bought a Tri Metric Amp-Meter. A cute little thing. But, what are wire sizes: #26 gauge, #24 gauge...I have not found a conversion table for converting your wire sizes into mm. Would you please help in publishing a conversion table or a formula.

Having read your article on the Staber washing machine I wanted to order one. But after an accumulation of pitfalls I bought a washing machine in Germany.

1. The leaflet sent to me from Staber Industries was not really sufficient. Why should an electric motor be rated in horse powers and not in Watts? The leaflet does not specify energy consumption over one cycle, nor does it tell how much energy is used while spin-drying. How is the water heated, externally or internally? I guess externally.

2. I had already bought a transformer 110–220 volts. But then a friend told me that the 60 Hz needed vs. the 50 Hz of a 220 volt inverter would reduce the advertised efficiency. Transforming 110 volts at 50 Hz to 220 volts at 60 Hz seems to be a bit more complicated?

3. Transportation costs are really high. I am still negotiating with Alternative Energy Engineering on how to transport two Harris Hydroelectric Systems. Now having cancelled the order for the Staber washing machine the shipping quotes are: to Germany $180.56. to Tanzania $608.00—Africa is really far off.

I had some nice crackers from my solar cooker in January. From the beginning of June up to October there are only clouds and fog floating through the kitchen, at 1350 meters altitude. Many people around were fascinated by the solar cooker, but nobody would dare to use one for fear of theft. What subsistence farmer or employed person at the monthly salary of $50 would leave a solar cooker at $20–$30 unguarded in his compound together with his precious aluminium cooking pot while attending his field?

I would enjoy an article on a solar cooking scheme in a Third World country that functioned. Up to now I have only come across expatriates like myself, who enjoy some solar cooking.

I have installed three PV systems. But "PV people" here recommended the use of truck batteries for storage, as these are locally available/produced and in the long run cheaper than solar batteries, which have to be imported from Europe. There is no way to get anything like Trojan batteries and all the VARTA solar batteries I know of have lasted a mere three to four years. I do not know whether this was due to poor maintenance or to the inappropriate design of these VARTA batteries, in which the lead plates are too densely packed. You are advertising a call for volunteers to install PV systems in Africa. For sure Africa is big and markets differ, but here in Tanzania at least a major concern is the maintenance after the expatriate has left. Where are local people going to buy a new solar battery if there are almost none on the market?

You had a picture of an electric Land Rover. I love driving our rough roads in a Land Rover, only this sting of guilt, age old energy wasted, air polluted, accompanies me. But, a short calculation tells me, electric?—no way. No trip is less than 300 km, rough road and tarmac and the Land Rover is not a commuter car or fun-car. It is used to transport never less than 600 kg. Hydrogen?—but not even you, as far as I have understood , who do have access to new equipment, use hydrogen for your truck. Is this due to lack of funds or is the hydrogen technology not yet ripe?

I have been following the discussion in HP on equalizing batteries, but I must be a bloke, I have not yet understood how you do the equalizing. I am using a pulse modulated regulator without an option for equalizing. Do you disconnect the panels from the regulator and run the wires directly on the batteries? Would a switch on either the positive or negative wire do, the other wire being the one running over the regulator? How long and how often should such an equalizing be done? Tomas Caspary, Tanzania

Hello Tomas. I agree, metric measurement system makes much more sense than the arcane system used in the USA. And in no place is American standards more arcane than wire gauges. Here is a table which relates the American wire gauge to the diameter of the wire in millimeters. This should help you find roughly equivalent metric wire sizes for your TriMetric Meter installation.

Copper Wire Table- AWG to Metric

American Wire Gauge Number (B&S)	*Diameter in mm at 20° C.*	*Meters per Ohm at 20° C.*
OOOO	11.6800	6219.0000
OOO	10.4000	4932.0000
OO	9.2660	3911.0000
O	8.2520	3102.0000
2	6.5440	1951.0000
4	5.1890	1227.0000
6	4.1150	771.5000
8	3.2640	485.2000
10	2.5880	305.1000
12	2.0530	191.9000
14	1.6280	120.7000
16	1.2910	75.9000
18	1.0240	47.7400
20	0.8118	30.0200
22	0.6438	18.8800
24	0.5106	11.8700
26	0.4049	7.4680
28	0.3211	4.6970
30	0.2546	2.9540

For conversion purposes, one horsepower equals 746 Watts. Kathleen reports that her Staber washer consumes an average of 251 Watt-hours of energy per load of wash (this is roughly the amount of energy produced daily by a single PV module). The water is heated externally, but the Staber is very water efficient and uses less hot water than most washers. Your friend is right, while it is a simple matter to change ac voltage via a transformer,

it is very difficult to change 50 Hz electricity into 60 Hz electricity. Most electric motors designed to run on 60 Hz will work very poorly (slow and inefficient), if at all, on 50 Hz ac power even if the voltage is right.

The experience of many RE systems in developing nations has led me to believe that batteries should be purchased locally. If you think that international shipment of a washing machine was difficult and expensive, try shipping batteries. Use the best you can find locally. Then when the batteries wear out (and they will regardless of where they are made), they can be locally replaced. Maintenance is the key to long battery life. Maintenance starts with a proper recharge regime—completely and regularly recharge the battery! Use only distilled water to replace lost electrolyte! Keep the tops and connections on the battery bright and tight! The three to four year lifetimes you mentioned are not bad. I've seen the highest quality battery ruined within a year. If you are getting four years out of what is essentially an automotive starting battery, then you're doing well. An equalizing charge is a controlled overcharge of an already completely recharged battery. The equalizing charge is carried out at no faster than the C/20 rate (divide your battery's capacity in Ampere-hours by 20 and you will get the maximum equalizing charge rate in Amperes). Carry on the equalizing charge for no more than seven hours. Be prepared for the cells to consume lotsa water. If your PV charge controllers do not allow defeat of the voltage limit for equalization, then either bypass (both positive and negative) the controller, or replace it with one which allows equalization. Equalization charges are an integral part of lead-acid battery health.

There is still no electric vehicle answer for those of us living in the back country. The long distances, rough roads, and mountains make EVs still a dream for us. For example, electric vehicle expert, Michael Hackleman, estimated that it would take at least three changes of batteries to get us to town and back (a round trip of about 200 kilometers with a gross altitude climb of over 1500 meters, and a cargo weight of about 450 kilograms). Hydrogen is still a dream for 4WD trucks. We do just like you do—buy gasoline and wish for something better. Richard Perez

Wanted: Pen Pals

For about ten years I have been collecting information on domestic wind plants. Amateur research is often slow in providing new info. Two years ago I placed an ad in Wind Power Monthly and now write exchanging information with someone in France. It seems to me that your magazine would be more suitable to attract someone of like mind. I wonder if you might insert a couple of lines—Australian person wishing to write to someone interested in the history of wind generators.You can see my desire for contacts and I hope you see this as a genuine plea for help. Michael Krusel, 14 Bishop Street, Oakleigh 3166, Australia

Here goes, Michael. We've printed your address so let us know what happens! Richard Perez

Computer Help Needed

In reading the many articles that you write, I know you have a computer that you run in your home and business using alternate energy. What computer and/or system do you use? Do you have a battery back-up connected to the computer or do you run it off an inverter or generator?

We have a Trace SW 4024 inverter as well as a 12 KW Leister and 5 KW Honda generator. We really need some answers as we have burned out two motor drives on our computer. We have been told that we cannot use a computer on alternative energy but we know you do so successfully. Any help you can provide will certainly be appreciated. Richard Peterson, Kodiak, Alaska

We use three full-sized Macintosh computer systems (two Mac II Cis and one Mac II Cx) and two smaller ones (Mac SE and PowerBook 160). The full-sized systems have many peripherals—big screen color NEC monitors, MO drives, scanners, modems, and ancillary hard disk drives. We have never (and I mean never) had a problem that was related to the quality of our electric power. All of these computers are powered by an Exeltech 1000 watt sine wave inverter sourced by our main PV/Wind/Battery system. We never (and I mean never) plug our computers into our 120 vac engine/generator. Even though our genny is of relatively high quality (a Honda ES6500), its power quality (voltage regulation and Hz) cannot match a good sine inverter power quality.

I'm betting that your fried computer equipment is due to powering it from one or the other (Honda's have good voltage regulation, the Lister's not so good) of your gasoline generators. Gas genny's have a wide variation in the peak-to-peak voltage (Vpp) of their output. Even the frequency of their power varies widely when compared with a good inverter or even the grid. Your Trace inverter, when inverting, already supplies power than is of higher quality than can be supplied by an electric utility grid. When your Trace goes into battery recharging mode, then all the loads normally powered by the Trace are transferred directly to your engine/generator. If your genny is running fast, then the 120 vac power supplied to your computer equipment will see high Vpp and high frequency. If the genny is running slow, then the power will be low in Vpp and low in frequency. Either of these conditions can cause damage to appliances, particularly to delicate electronics such as computers and communication equipment. Have a knowledgeable nerd with a good digital multimeter (like the Fluke 87) record the peak to peak voltage and frequency of your generator while powering the Trace's charger and also all computer loads connected to the Trace. I'll bet you find that the 120 vac power supplied by the genny is way out of spec. I'd check the Lister first. Richard Perez

Brighter LEDs

Manufacturers are making brighter LEDs than previously mentioned in Home Power articles. Last I knew Radio Shack has a Jumbo sized LED that could put out about 5,000 mcp, or something like that. One idea to get some LEDs cheaply for indicators is to remove them from broken electronic devices (toys, old VCRs, etc.). Just make sure all power is removed and capacitors have had time to discharge for safety reasons. Don't worry if the case is broken or the device has been submerged, LEDs are not fragile. I'll have to write an article about my hand powered LED flashlight I made. I'll have to make another one though, the original is somewhere in California and I have new ideas.

Digi-Key has a huge variety of LEDs and LED assembly's ranging from stop light size to surface mount. Interestingly there is some in Digi-Key's catalog that are made to replace panel lamps that are listed as "near white." One place other than Radio Shack I have received LEDs from is Electronics Gold Mine, they have blue LEDs. Free Catalog: Electronic Gold Mine, PO Box 5408, Scottsdale, AZ 85216, 800-443-0697. With Solar to All, Larry LaBranche, Augusta, Georgia

Hello Larry, check out the "Things that Work!" article on Jade Mountain's PV/LED lighting system on page 74 of this issue. More and more folks are realizing that when it comes to converting electricity to light, then nothing comes close to the

light emitting diode (LED). We use LED lighting all night, every night, and we can hardly notice its energy impact. Richard Perez

RTV Sealant
Regarding the letter from reader Jim Tolson in HP#55, I've included a copy of the box for RTV sealant #738 [Dow Corning® RTV Sealant/738 electrical sealant •100% silicone rubber • no corrosive by-products • no objectionable odor • -65°F to 392°F (-54°C to 200°C). Net 3 U.S. fl oz (90mL). Applications: Seal electrical connections—seal printed circuit boards—bonds wire entries—insulate power and control cable connections—insulate terminals, leads and splices—waterproof splices and electrical enclosures—make formed in place gaskets. Authorizations: FDA Regulation No. 21 CFR 177.2660; NSF Listed, U.L. Recognized. Restrictions: Most paints do not adhere. Not recommended for underwater use. Do not use in totally confined application. Must have moisture from atmosphere to cure. Storage: Store below 80°F (27°C) in a dry place.] We use this RTV to seal electrical connections on our product line of aircraft landing lights and exterior navigation lights. Mr. Tolson is correct, it is not easy to find, but an industrial supply house should be able to order it. Note that this product MUST have moisture from the atmosphere to cure! Scott Winneguth, Project Engineer, Soderberg Mfg Co Inc, Ontario, California

A Reprint
The following is a copy of a letter sent to the Milwaukee Journal by Home Power reader, Michael Mangan of Delafield, Wisconsin.

Dear Editor:

As scientific evidence increases supporting the greenhouse gas global climate change theory, European and Asian insurance and banking industries are accepting the evidence and taking steps to protect against future financial losses like Hurricane Andrew by investing in non-fossil fuel sources like solar energy.

Typically , the U. S. corporate "earth is flat" mentality of denying any greenhouse gas effect is threatening both the present U.S. economy and its long term strategic interests. The two headed special interest dragon of coal and oil come before U.S. energy independence and a greater good for the U.S. citizens.

Because the Asian and European banking and insurance industries, i.e. Munich Re, Swiss Re, and Lloyds of London, have acknowledged the threat of global warming causing natural disasters of greater frequency and strength (since 1990 the insurance industry has paid out $48 billion for weather related losses compared to only $14 billion for the entire decade of the 1980's). investments in renewable energy will occur in both continents causing many U.S. renewable energy firms to leave the U.S.

Current solar technology advantages will evaporate as the market and production shifts off shore causing the U.S. to once again play catch up. Eventually corporate America might pull its head out of the the scientific, economic and environmental sand of global warming. Until then I hope people of vision challenge the corporate and political forces of denial to move forward to a sustainable, non-fossil fuel, energy future for the U.S. and the world. Michael Mangan, Delafield, Wisconsin

Renewal
My only complaint is your policy of not sending renewal notices. Just like last year, I missed the notice on the mailing label until just now. The fact that your mailing notices are attached upside down doesn't help a bit. Who turns it 180° around and looks at it? Certainly not I. If and when I do see it, it's purely by chance. I want my subscription to continue without any omissions. I don't want to miss an issue. Per Winckler, Andrews, North Carolina

Hi, Some folks like our current renewal policy, some don't. Our database, 4th Dimension, will allow us to add a field so we can send a postcard to those who need/want one when it's time to renew. It will take a bit of doing but hopefully by #58 you'll find a new box on the subscription form. How about it readers, do you need to be sent renewal notices? Karen Perez

Best College for RE
Just ordered the subscription for my son, a senior in high school who is interested in pursuing his education in alternative energy. Have you published a listing of colleges and their environmental engineering, or alternative power programs. Which is the highest rated? Which should we avoid? He is beginning a senior project and has a local mentor. I would like to contact others in Southwest Pennsylvania who have retro-fitted homes or are home builders/designers with experience who might speak with my son. Any help can be e-mailed to: envision@igc.apc.org. Thanks, J. Yeager, Chester Springs, Pennsylvania

Sorry to say, but I've no idea where a good college level education in RE can be had. It's been some thirty years since I went to college (in Physics) and all I've learned about RE has been in the field, not the classroom. I'll print you letter here and maybe our readers who are attending colleges now, or in the recent past, will contact you. Richard Perez

Great Stove
Kudos to Kathleen Jarschke-Schultze for her article on the Peerless-Premier gas range (HP#40). We recently bought one—best stove we ever had! We converted from electric to gas & also did the same with our water heater. Result: we cut our electric bill in half & expect to save $200.00 a year in fuel costs. Richard A. Kenyon, Foster, Rhode Island

Enjoying 12 Volt
Thanks again Home Power. I've been offgrid fourteen months now and I wouldn't have done it without the benefit of having seen other people's systems in your magazine. Primarily solar-powered, supplemented by hydro in the winter, I have stayed with an inverter-less system. I enjoy the novelty of a 12 Volt system although I do spend a bit extra on copper.

Would like to see an article on components available for homemade solar water heaters. Also hope to see reviews of composting toilets in the future. John Swatosh, Brush Prairie, Washington

We are working on those articles now, John. We are about half done with our combo greenhouse/bathhouse. It will feature both solar hot water and a composting toilet. Expect to see some articles about this in the coming year. Richard Perez

Recommendations
How come we never see any information about Vestfrost refrigerator & freezers? We have had a refrigerator for two years now and love it. Very space efficient, and what a step up from a cooler and ice blocks! Very soon we are going to add the 7.5 cubic feet freezer.

Also just purchased a Staber 2000 washing machine (a lot due to your review & recommendations). What a great addition to our lives. Steve and Cindy Nicholson, Berkshire, New York

We've never tested a Vestfrost unit. There are many great products and we are a very small crew. You don't have to work at Home Power to do a "Things that Work!" article on a product. You do, however, need to be financially disinterested in the product

(not the manufacturer, or distributor, of the product). Read past TtW! articles to get an idea of the style. We like to see an independent test done in an actual working RE system. The basic criteria for Thumbs Up are simple. The product must meet its maker's specifications. The product must last in actual service. The product must offer good value for the money spent on it. Why not write up your Vestfrost and send us the article? Richard Perez

EDTA

In HP#55 you advised readers not to use EDTA to rejuvenate auto batteries—Why Not—I used it on an eight year old Die Hard LT that would no longer hold a charge. It has worked like a new battery for more than a year now. It was even used to start a diesel farm tractor this summer. The stuff is cheap—you've nothing to lose—try it. Thomas J. Houseman, Rapid River, Michigan

Glad to hear that the EDTA worked on your Die Hard battery. We have used several of these Sear's Die Hards over the years and they do seem to be a cut above the average, consumer grade, L-A battery. Most "car" batteries don't have rugged enough plates to survive the EDTA treatment. Car batteries generally have their plates made of a very fine lead sponge. The idea is maximum surface area with minimum weight (this is a car battery). Evidently your Die Hard has thicker plates than most batteries of this type. You are definitely right about having nothing to lose. EDTA is indeed cheap and and if the battery is dead anyway, then why not give it a try. Richard Perez

Earthship

My wife and I are presently building an Earthship type home in the mountains of SE Oklahoma near Heavener. We are surrounded by the Quachita National Forest and abundant wildlife. Our nearest power source is over two miles away and it can stay there as far as we are concerned. We have a tent trailer on site with a very small PV panel keeping our two batteries charged for lights at night. We will be completely PV powered when we finish the house. We have purchased two solar water heater collector panels at a garage sale for $10 each and plan to build our water heater system around them. We are building our solar toilet so we don't pollute our ground water. We have a spring fed creek that starts 1/2 mile above our property that we are presently using water from for taking showers and watering our plants. Also we use the water for mixing concrete and adobe. Your magazine has helped me greatly with my design for my system. Thank you. Leroy McLaughlin, Mesquite, Texas

We are glad to be of service, Leroy. Keep us posted on your RE system as it develops. We are also interested in Earthship building techniques, how it went together, how much it cost, and how is it working? Richard Perez

Workers Off Grid

Love your magazine. We have moved to a four acre site and plan to build (20 year old double wide current home) either "stock wall" or straw bale or a combination. Site well suited for wind power (highest point in several miles) and solar power. We will be doing most of it ourselves so it may take time!

My son is a nuclear power plant operator and plans to be totally off grid power by age 65 (in 33 years), as do most of his co-workers. We share info! Marjorie Stroud, Stark, Kansas

I am no longer surprised by the number of people who work in commercial utility power and who are interested in stand-alone RE systems. They must know something we don't…or do we? Richard Perez

Haitian Solar Project

Just subscribed to your magazine after buying it off the shelf for the past two years. Thank you for its content and inspiration. I have just returned from two weeks in Haiti, where I worked at an orphanage for abandoned children and those left from the deaths of the boat people. An organization called Mission Haiti, based out of Swannanoa, North Carolina and myself installed a small solar system for the orphanage to provide lights, small appliance and tool use.

There are so many projects to be done there, I came home with three to work on over the coming year. One is a small hospital for the orphanage that I would like to design and build a 2KW photovoltaic system with generator backup. We are also in the midst of designing a water tower system to provide pressure and water to the orphanage, volunteer guest house and hospital. DJ Lesco, e-mail: Lesco@fortwayne.infi.net

Great work, DJ! We've done some system work in developing countries and it is indeed very satisfying. I think that the most important and most overlooked feature of these systems is education. If the system is to live a long life, then training someone local to maintain it is essential. Same goes for system siting, design, and installation. Next time we do a system like this, it will be based around a series of workshops training locals to carry on the process when we leave. I think that the education is possibly more important than the hardware. Richard Perez

Un-neighborly

Like many of your readers, I live out in the boonies where city people like to come in their vehicles and "get away from it all." The trouble is, they always leave their beer cans, bottles, trash and other signs behind. This wouldn't be so bad by itself, but they also ride their motorcycles all over the place and (this really gets my dander up) they shoot all manner of high-powered rifles and submachine guns—not just during the day but sometimes all night long! I've called the sheriff a number of times and the perpetrators usually calm down for an hour or two, but then they just start up again, knowing that it'll take the cops too long to come back again.

The problem is, according to the sheriff's information officer, that all the land around my place is all privately held by absentee land investors who don't know or complain about people camping or shooting on their land.

What can I do? What have some of your readers done in similar circumstances? I don't have a gun and I don't want to deal with my fellow humans on the basis of who's got the biggest or most guns. Every weekend more people come and get wilder and wilder. I really feel like I wish I could have this vacant land closed to motorcycles and guns.

Before I close I would like to congratulate you on a great magazine that has been of invaluable assistance in our off-grid survival. Douglas Parham, Palmdale, California e-mail: Psdmesq@qnet.com

Well, Douglas, we have the same problem and have yet to find a solution. In our neighborhood, the main access road is on private property. Our neighbor, who owns most of this property, has placed locked gates on the roads to limit the traffic. He has had many ugly disputes with hunters and off-roaders. Locked gates only work if there is someone on site to protect the gate. Otherwise, it is common for folks to wreck the gate and drive through anyway. Then we get into property damage and more cops. The problem is irresponsible and inconsiderate people. Anyone got a solution? Richard Perez

Longer Than A Year
I wish you would add a sentence to the renewal instructions: "We can accept up to 3 year advance renewal." ??Can you accept 5 years?? ??Can you accept 10 year?? If you can accept 10 year,. then a Lifetime subscription should be available at about three times the ten year rate—when considering the time-value-of-money. James R. Eckel, Culver City, California

Hi James, We routinely accept two and three year renewals. We've even had two or three trusting folks send in ten year renewals. We haven't really thought about taking lifetime reups. Phew—that's a lot of paper for a lot of paper! I can't imagine that anyone would be interested. Karen Perez

A Big Favor
Hello from a grateful subscriber. I fax to ask two big favors. One: for the N.G.O. Shanti Progress with which I work—the simplest, durable design specs. for a desert condition solar oven. We need to manufacture (wood/aluminum?). Two: Engineering buffs, (friends) are eager to build solar electric transports for demonstration here in Delhi. Proper D.C. motors are impossible, however. Any information on new or used sources, specs., and costs would be permanently appreciated.

I am sorry to impose and will be pleasantly surprised if you all have time to help me. Thank you for HP, Peace from the East, Gavin, Shati Progress (Khosla), 663 New Rajender Nagar, Double Story, N.D. 110060, India. Fax 011-91-11-7777413 or 3555020

Hi, Solar Cookers International has simple, easy to build solar cooker plans. They are a wonderful non-profit group that is doing fantastic work—particularly in Africa's refugee camps. Write to: Solar Cookers International, 1919 21st Street, Suite 101, Sacramento, CA 95814 USA, telephone: 916-455-4499 • e-mail: SBCI@igc.apc Karen Perez

Check out Tara Miller's article on solar cookers in this issue. We ran an article about EVs in Kathmandu, Nepal in HP#49, pages 52–56. These "electric rickshaws" use an Advanced DC series wound, K91-4003, 72 VDC motor. You need to contact Jose Baer, Blue Heron Design, 4625 P Street, Sacramento, CA 95819 • Tel/Fax: 916-452-4850. Richard Perez

Teaching Materials
I teach Building Maintenance at Central Arizona College. I'm considering incorporating some renewable energy theory and training into my curriculum. I would appreciate any recommendations on titles and publisher(s) of quality textbooks covering these subjects. William Pertzborn Jr., Coolidge, Arizona

Well, William, we've mostly learned by doing, but we have encountered several good college level texts. Our favorite is written by Eduardo Lorenzo (from Spain) and is entitled "Solar Electricity" (ISBN: 84-86505-55-0). Another thorough text is "A Power for the World—Solar Photovoltaics Revolution" by Ljubisav S Stamenic and George W. Ingham (ISBN: 0-9680062-0-5). For a less theoretical, hands-on, book check out "Solar Electric Systems for Africa" by Mark Hankins (published by Commonwealth Science Council, Marlborough House, Pall Mall, London SWIY 5HX, United Kingdom). Richard Perez

Planning Dreams
I have been planning to build an RE solar-powered cabin in an intentional community I belong to for about five years. Home Power helps me keep my dream alive by consistently featuring homes that have already done it! I plan to have PV modules on a tracker with battery storage to power lights and small appliances in the home, propane refrigerator, on-demand water heating and cooking, and solar-powered water supply system from a well. A conventional gravity fed septic system will be used. Clothes washing will be done in one of the manual jobbies on the front porch and, of course, solar clothes drying will be used. I will be breaking ground in the Spring of '97. It is a 700 sq. ft. cabin with board and batten siding,standing metal seam roof, and dry stacked stone work. The community, Potluck Community Farm, is in the Piedmont of North Carolina, and consists of eleven families, each with three acres, and about 140 acres of commonly owned rolling hills, forests, creeks, and a pond. We have an apple orchard planted with about 40 varieties of old timey apples from early ripening and apple pie apples to late ripening and good root cellar varieties. We have one more share to sell in our community and we will be filled. I can be reached on e-mail at tbg@rti,org. Thanks again to Home Power for helping my dream of an RE home to fruition. Tom Grizzle, Chapel Hill, North Carolina

You've already learned the major lesson about RE—plan ahead! Maybe one of our readers will be interested in the remaining share in your community. We are proud to help in any way we can. Thanks for the flowers, Richard Perez

Real Home-Made Wind
Just a thought that has been caught in my mind for a long time, like some tune you can't forget. About 30 years ago I worked for a consulting engineering firm in Denver. Two of the fellows that I worked with would make an annual pilgrimage on their dirt bikes from San Diego to the southern tip of Baja California and back every year. We always had an interesting picture show of their trip to peruse. What sticks in my mind is a picture of a very isolated Mexican farm. The owner, an older fellow of indigenous stature, had taken what looked to be a couple of old cars (perhaps 1938 chevrolets or there about) and built himself a home power system from the hulks. He stacked the hoods and an axle to make a tower and mounted an auto generator with home built blades on it to charge his batteries. He used the light bulbs and fan motors for his needs.

The thought that has stuck with me all these years is that all throughout this country we have vast resource centers (also known as auto junk yards) just going to waste. It would seem that with many people living on Indian reservations could benefit from this wasted resource if someone just put some kind of a program together. I do not know if this idea would be accepted by the peoples of these various Nations but it certainly seems worth exploring. Perhaps a service of a home power domestic peace core could teach a cadre of the younger people on these Reservations how to set up a cottage industry to produce a system of home power and literally wire a Reservation.

I hope that this is not to wild of an idea and if anybody has thoughts on this I would appreciate hearing from them. Judging from the project of thirty years ago it does not seem to take a rocket scientist to produce power in primitive conditions with limited resources. Walter Jankowski, 155 Venus Road, Golden , CO 80403-9027 •303-582-5358 •E-mail: Wjankow477@aol.com

Your idea is far from wild, Walter. Twenty years ago all of our lights, motors, and the alternator that sourced our system came from auto junkyards. I even reused the bulb sockets from auto tail lights, switches from the dash, and soldered together wires scrounged from cars. A junk auto is a gold mine of low voltage parts and the price is certainly right. Most junk yards consider these electrical bits and pieces as "junk" and sell them very cheaply, or sometimes even give them away. If you couple this junk to a major power producer, like a PV module or a

homebrew wind genny, then you can have an electrical system for very low cost. Richard Perez

Where To Start

I have been thinking for a while about getting solar power in my home, but frankly, I don't know where to start. I have several questions, such as: Does it pay to do it at my latitude (middle of Long Island)? How much does it cost? How do I establish the best location on my property? How much decrease in my present energy costs (I have an "electric" house) can I expect?

Since you are an expert on the subject, perhaps you can either give me some answers or else tell me where I could find them? I would be very happy to be able to solve this problem. Thank you very much in any case. Professor Franco Jona, SUNY, Stony Brook, New York

Your latitude has little to do with the effectiveness of solar electricity. We have many readers using solar electricity in Alaska. What does count is the weather. I imagine that Long Island has its share of cloudy days. The cost will depend on how much electricity you use. Here is a a very general estimate. Please consider that is is very, very, general and will vary depending on location, and your power requirements. A 1 kWh per day system can be established for less than $5000. Add about $2500 for each additional kWh per day required. This is for strictly PV-sourced systems, installed using high quality components. Add a second RE input (in your case maybe wind) and the cost goes maybe up and maybe down depending once again on your weather (i.e solar insolation, wind resource, or possible hydro potential).

The only way to find the best location on your property for the PV array is to use a Solar Pathfinder. See the article on page 32 of this issue. Don't even consider specing and installing any PVs without doing a Sun Chart (like the Pathfinder supplies) for that specific location. A few feet either way can make a big difference, especially in the winter when the shadows are long.

If you are grid connected, then going to PV electricity will not save you any money on your electric bill. PV is not yet cheaper than utility power. But PV does have its advantages—you know where your power comes from, you own the generating source, and it is supremely reliable.

If you have an "all electric" home, then you can easily save money on your power bill by reducing your electric power consumption. Move from electric space heat to another source—direct solar (at the same time insulate the hell out of your building, ie. reduce the building's thermal consumption). Get rid of your electric hot water heater and use a solar hot water system (at this point in time, this move will save you money and pay for itself in about three years). Get your cook stove off of electric power and put it on gas (every good cook I've ever known dislikes electric stoves). Replace incandescent lighting with compact fluorescents. Replace your under-insulated, auto-defrosting, spits-ice-cubes-out-the-door, refrigerator with an energy efficient model such as the Sun Frost. Put plug strips on all your Phantom Loads. Reducing your consumption is the first step to affording solar electricity and it immediately saves you money on your utility bill. Richard Perez

Utility Comments

I would like to make some comments about Don Loweburg's collective in Home Power #56. As an engineer for a large power company (Not PG&E), I would have also required a visible, lockable switch. This would NOT be a requirement for most utilities, as I suspect of PG&E. This is a government mandate from OSHA. Many of us in the electric industry don't like the government mandates either. But because the electric industry is one of the safest, for workers, OSHA had decided that we need more regulations.

As for using the electric meter as a disconnecting device—the connecting ears were not designed to do this repeatedly. As a PV owner myself, and just otherwise, I am not happy with the requirement of having an external cutoff device. (It is required by local code here). I do have some comments on Net Metering but, I will let them slide for now. (I am just glad we don't do it here, as a customer.) Name & Address withheld by request.

A Very Sincere Thanks

Hello Home Power Crew! If at all possible, I would like to see that this gets in as a letter to Home Power. The reason is I want to thank everyone who has responded to my article in HP#56, "A Kid Hooked On Wind Power." I would like to thank you, the HP crew, for taking the time to go through and print my story in your most glamorous magazine. I would also like to thank Robert Allen for sending me the original six foot Wincharger prop for the Zenith. Thanks, Robert, it looks great! And don't worry, I'll see that it gets lots of attention and is well taken care of!

P.S. I forgot to tell you, the readers, that I have 223 amp hours of recycled deep cycle batteries with my system. The only cost of the system was the permanent magnet motor/generator for the turbine and battery lugs; costing about $40 all together. Thank you. Corey Babcock, Lewiston, Minnesota

Writing for **Home Power** Magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale, renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your RE experiences printed in *Home Power*.

Informational Content
Please include all the details! Be specific! We are more interested in ispecific information than in general information. Write from your direct experience—*Home Power* is hands-on! Articles must be detailed enough so that our readers can actually use the information.

Article Style and Length
Home Power articles can be between 350 and 5,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences. Sentences which are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in *Home Power*. After you've studied a few, you will get the feeling of our style. System articles must contain a schematic showing all wiring, a load table, and a cost table. Please send a double spaced, typewritten copy if possible. If not, please print.

Editing
We reserve the right to edit all articles for accuracy, length, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get published first.

Photographs
We can work from any photographic color or B/W, print, slide, or negative. We prefer 4 inch by 6 inch color prints which have no fingerprints or scratches. Do not write on the back of your photographs. Please provide a caption for each photo.

Line Art
We can work from your camera-ready art. We can scan your art into our computers, or redraw it via computer. We usually redraw art from the author's rough sketches. If you wish to submit, via computer file, a schematic or other line art, please call us via telephone.

Got a Computer?
We use Macintosh computers to make *Home Power*. We would like your article's text on 3.5 inch computer floppy diskette. This not only saves time, but also reduces typos. Please also send a hardcopy printout of your article in case the electronic copy doesn't work. Please format all word processor files in "TEXT" format. We can also read text files on 3.5 inch IBM disks (800 KB, or 1.4 MB). Please format the IBM word processor files as ASCII TEXT.

You can send your article via modem to either the HPBBS at 707-822-8640 or via Internet as an enclosed TEXT file(s). HPBBS address is: Richard Perez

Internet email address is:
richard.perez@homepower.org

It is wise to call, via voice, ahead of electronic file submission. This is particularly true concerning graphics files. There are many, many ducks and they all need to be in a row....

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Michael Brown

I'd like to open an ongoing conversation with you about electric cars. Specifically, I'd like to answer your technical questions. I've been in the EV business for eighteen years, so I've had the opportunity to collect a lot of information, both through my own trial-and-error education, and from the many EVs I've had a chance to examine. I'd like to share what I've learned, to make your EV experiences easier and more pleasant.

I'll lay out my bias right up front. I'm heavily into practicality. That comes from twenty-eight years of servicing and repairing gas cars. I believe in simplicity, reliability, and affordability. I favor middle-of-the-road technology, not out-of-production orphans or unproven experiments. I keep an eye on the new technologies as they develop, but I wait for them to prove themselves before I recommend them.

Over the years, I've also acquired a good network of EV technical advisors, and I can share their knowledge with you as well. If I don't know the answer to your question, I'll research it, and we'll both learn something.

A frequent question I hear is, "I think I have a bad battery in my pack. How do I find out which one it is, and what is the procedure for installing a new battery in an existing pack?"

If you notice a decrease in range more than twice on the same route, check the easy things first: soft tires, wheels that don't turn freely, even cold weather. These factors will all effect range through increased rolling resistance or reduced battery capacity. If none of these conditions exist it's time to check batteries.

Start your search for the weak battery after the pack has been discharged. Wait until the EV has been parked for at least an hour. While you wait, number your batteries and prepare a chart with the battery numbers down the left side of the page and five vertical columns about 1" wide across the page. Label the columns Discharged Voltage, Charged Voltage, Cell 1, Cell 2, and Cell 3. If you are using 12V batteries you need three more columns for cells 4, 5, and 6.

Now begin testing by touching the probes of your voltmeter to the poles of the #1 battery. Record the voltage and move on to the next battery. When you are done with all the batteries, put the pack on charge and note the starting time.

While the pack is charging, review the voltages you took. If one or more batteries is .05 volts or more lower than the others, you have your first clue. Try to note when the charger shuts off or drops to its low amp output phase. If the time it takes to reach this point is longer than usual, you have another clue.

Disconnect the charger and drive around the block to knock off the surface charge. Now repeat the voltage check of the individual batteries. It's best to have an assistant write down the numbers, and to move through the pack briskly. The batteries will be regaining a surface charge as they sit, and if you take too long, your readings will be skewed. If the batteries that were low in the previous test are low in this test also, you have another clue in your search.

Now is the time to get out your hydrometer and check the chemical condition of the batteries in question. Rather than go through the time consuming and messy process of checking the whole pack, I prefer to test the batteries on each side of the suspected battery and the suspect itself.

Number the cells consistently, starting at the negative terminal on each battery. Do the hydrometer test and record the results on your chart. If you are using a temperature compensating hydrometer, be sure to do the compensation before recording the reading. A difference of 10 points between the cells of a battery is ok, but 30 to 70 points is an indication of a bad cell. If you find that your low battery in the voltage tests has one bad cell, you have found the culprit.

An EV battery usually fails at one of two times in its lifespan: shortly after the pack is installed, or after the pack has been in service for three to four years. If the failure occurs after three years, it's best to replace the whole pack. Installing a new battery in an old pack will result in damage to the new battery. It will come up to a full charge faster than the old batteries, and be overcharged while the older batteries catch up.

If you have a young pack (up to three years old) with one bad battery, you need to install the new one so that it starts its life at an equal level of charge with the rest of the pack. Remove the bad battery and install the new

one, but don't connect it into the series yet. Instead, connect the other batteries around it with a jumper wire (at least 10 ga. wire), completing the series but isolating the new battery.

Next, take a hydrometer reading of the new battery and the batteries on either side of it. Write these readings on your chart. The new one should have a higher reading. Now plug in the charger and charge the pack until the hydrometer readings of the old batteries match the readings of the new one. Shut the charger off, disconnect the jumper wire, and re-install the original battery interconnects. Start the charger again and let it run until it shuts off or goes into its low amp output phase. At this point, the new battery should be integrated into your battery pack, and you should note a return to your previous range and performance levels.

Now I need to hear from you to keep this conversation going. Send or FAX your EV technical questions, and let's talk about them.

Access
Author: Mike Brown, EV TechTalk, Electro Automotive, PO Box 1113, Felton, CA 95018 • 408-429-1994 • FAX 408-429-1907

Q&A

Garage Door Opener Fix

Re: Mr. McCarty's letter in HP56 on GDOs and a sleeping inverter. Mr. McCarty is to be congratulated on getting his house's energy budget so squeaky-clean that his inverter can sleep while he goes off to work! As you pointed out, most people give up on getting things quite that tight. Modern conveniences like phone machines, fax, and VCR clocks tend to make us weaken.

The best simple idea I came up with—use a "mat" switch on the driveway. Home security systems put 'em under rugs, but in Malibu's serene weather it should be OK outdoors. This low-voltage switch could then trip a DC relay, which could then turn on an AC lamp. A relay coil of course would be the same voltage as the battery bank. I think this is about as simple as it can get plus, you get two side benefits! One, the lamp could illuminate the driveway area (and let you know you'd "hit the target"). Two, the threat from garage door hackers' rolling encoders would be just about zip: they'd have to be on the switch before any tricks would have a chance of working. Our urban area recently had a group of thieves who just drove around with a GDO remote set on its default code. It's surprising how many doors they opened, and how many garages they cleaned out! Kind of like all those briefcase combo locks which pop on 0000.

This still doesn't get him out of the garage in the morning, but I gather he's already figured out that end of the deal.

PS- re pg.46—two meters saving an eye and a leg. You ought to relate that to a ham magazine while it's still in the word processor. CQ, VHF? Arrl's new ham companion? Wayne Green @ 73? There's a lot of cross-pollination potential betwixt hams and solar energy waiting to happen. I'm still waiting for a Wisconsin ham group to do a special event station from MREF, even though Wisconsin is too close for me to hear. 73, Jim Tolson (KF9CI) • e-mail:Jtolson777@aol.com

Good idea, Jim. The "mat" switch should work and be relatively inexpensive and easy to install. Another HP reader, Jerry Appling of Mariposa, California sent me a spec sheet for a universal receiver for garage door openers. This universal receiver runs on either 12 VDC or 18–35 VDC and is made by a company called "Lift-Master". The model number is 412LM. This universal receiver would allow the radio portion of the garage door opener (or whatever 120 vac, radio-controlled, appliance) to be activated when the inverter is asleep. The Lift-Master universal receiver is available from Carl Smith at McClure Industries, Inc, 4907 East Lansing Way, Fresno, CA 93727 • 209-291-5536 for around $100.

I really should ship some of the PV/ham radio material out to the ham pubs. Thanks for giving me a kick in the butt! I just assumed that hams would already be using PV power for their stations. After all what good is a radio if there is no electricity to run it? Most ham stations could easily be satisfied with energy produced by a single 75 Watt PV module. I'd love to see a special event ham station at the Midwest Renewable Energy Fair. How about it hams around Amherst, Wisconsin? I know that many hams attend MREF because I've met them there. Even if this station ran the maximum legal power (2 kWp), energy would not be a problem with the Fair's extensive PV arrays and giant wind genny. The way I see it ham radio and PV power are made for each other. Richard Perez

Batteries and Gases

I have become a regular reader of Home Power over the last couple of years. I've found it most useful to carefully read your back issues which I obtained through your subscription department.

Many questions and problems I have encountered have been answered by your wonderful magazine and its knowledgeable readers; however, I now have a couple of questions that I haven't seen addressed in your pages.

Like many renewable energy users, my system incorporates battery banks in the basement of my home. Living in the northernmost part of Wisconsin makes it necessary to keep the batteries inside and warm during our cold and hard winters. I have two separate banks of 20 each GC-4 110 amp hour batteries. The banks each are arranged in five strings of four each to provide 1100 amp hours at 24 volts. Each bank has its own Trace 4024 Inverter. Transfer switches enable my PV system (two arrays each consisting of 8 Siemens PC4-JF 75 watt panels on Zomeworks Trackers) and my engine generators (Onan Marquis 5kw propane fueled) to be connected to the battery bank and inverter of choice. An ac transfer switch allows the inverter and battery bank of choice to be connected to the house distribution panel. As you can see, redundancy is a major concern.

Now to my questions. Our house is of new construction and is very tight. While I do have my battery banks vented to the outside by means of tubing and PVC pipe,

it has come to my attention that some hydrogen is entering the living quarters. When we reach full charge either by PV or engine generator our CO alarms give warning. They are made by Knighthawk and are of high quality. A call to the manufacturer says that they will detect free hydrogen, but that there shouldn't be any free hydrogen in your house!

At most my CO meters read less than 100 ppm. What percent (or ppm) is considered safe for hydrogen? In addition, are there any other gases emitted by charging or discharging lead/acid battery banks that are potentially harmful in a residential environment? Thanks for your help. David C. Killian, Marengo, Wisconsin • Crickett@win.bright.net

Are you equipped with HydroCaps? If not, adding a HydroCap to each cell will greatly reduce the amount of hydrogen you are releasing. You can order the HydroCaps from your local dealer, or contact HydroCap, 975 NW 95 Street, Miami, FL 33150 • 305-696-2504. Cost is less than $10 per HydroCap and you will need one for each cell.

You need to add an active venting system to your battery containment. First make sure that the containment is air tight. Don't forget that active venting requires an air input which is usually filtered (a couple of old nylon stockings works), and located at the BOTTOM of the containment. Add the active vent at the TOP of the containment. Duct the containment's air outside through well sealed PVC pipe. Most folks use 2 inch diameter pipe. I've been getting good reports on the Power Vent available from Cone Construction, PO Box 52, Salida, CO 81201 • 719-530-0718 • Internet e-mail: <coneco@rmii.com>. The Power Vent is inexpensive and closes down the vent to reduce backdrafts when the vent is not actively being used. The cost is low, $74.95 (plus $6 shipping). It can be controlled by your Trace inverter, or you can buy a separate controller for $64.

I have no idea how much hydrogen (ppm) is safe. I don't know if small amounts in your home's atmosphere constitute a long term health hazard. I do know that lead-acid batteries produce minute amounts of stibine (SbH_3) and arsine (AsH_3) gas during the final stages of the recharging process. Both these gases are toxic. The bottom line is: If your batteries are located within the living space's air envelope, then use HydroCaps and actively vent the sealed battery enclosure to the outside. Richard Perez

Wire Loss

I have 150 feet of 6 gauge wire and 150 feet of 12 gauge wire paralleled between batteries and house on a 12 Volt system. I've got the "wire-loss" blues. Short of moving batteries and panels or running more wire, is there any solution to getting more DC power through those lines? P.S. I bought DC fluorescents from Windy Dankoff. They help a lot. Patrick McGinn, Lamy, New Mexico

Sorry Patrick, but it's the law, Ohm's Law, that is. You simply have too much resistance. If you must move 12 VDC long distances, then the only alternative is wire sized to do the job efficiently. Consider installing some larger gauge wire. Carefully to solder every connection which can be soldered. When you make the inevitable mechanical connections, be sure to solder the connector to the cable. A good low voltage mechanical connection has two things: high contact pressure (bolt it down tightly!) and large contact area (don't use small connectors and bolts, use big ones). Richard Perez

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